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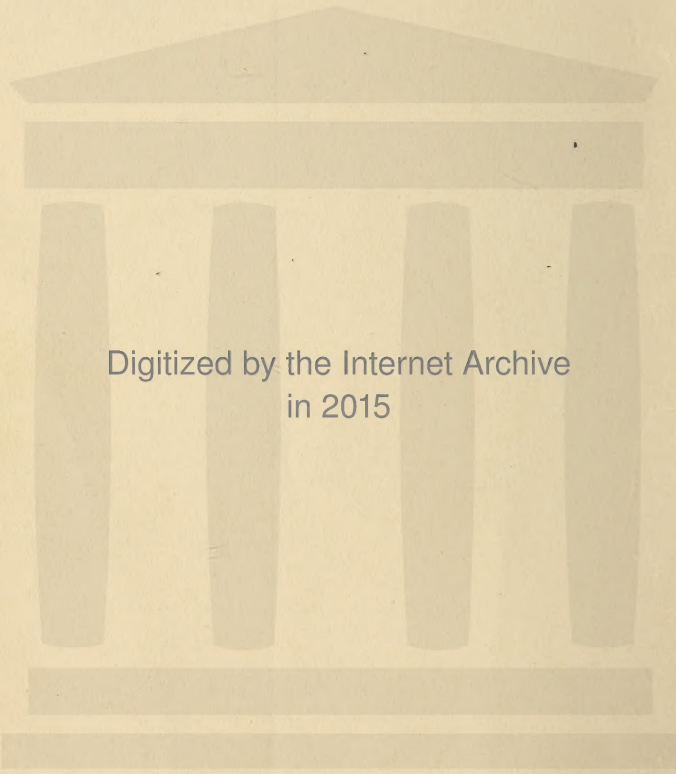
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STATE COLLEGE OF WASHINGTON
AGRICULTURAL EXPERIMENT STATION
PULLMAN, WASHINGTON

DIRECTOR'S OFFICE

INDEX
TO
GENERAL BULLETINS
1 TO 25
BY
H. B. CLEES
SECRETARY TO THE DIRECTOR

April, 1917

All Bulletins of this Station sent free to citizens of the State on
application to Director

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WASHINGTON AGRICULTURAL EXPERIMENT STATION

By

H. B. CLEES, Secretary to the Director

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WASHINGTON AGRICULTURAL COLLEGE
AND SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 1.

ANNOUNCEMENTS.

DECEMBER, 1891.

OLYMPIA, WASH.:

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ANNOUNCEMENTS.

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GOVERNMENT AGRICULTURAL EXPERIMENT STATION FOR WASHINGTON.

BY GEORGE LILLEY.

The Washington Agricultural College, Experiment Station and School of Science is both a state and a national institution. It was established by act of our last legislature, approved March 9, 1891. Portions of the act are as follows:

“SECTION 1. There is hereby established an institution of learning to be known as the Agricultural College, Experiment Station and School of Science of the State of Washington; said institution to be located as hereinafter provided on a tract of land containing not less than one hundred and sixty acres.

“SEC. 2. The Agricultural College, Experiment Station and School of Science created and established by this act shall be an institution of learning open to the children of all residents of this state, and to such other persons as the board of regents may determine, under such rules of regulation and terms as may be prescribed by said board of regents; shall be non-sectarian in character, and devoted to practical instruction in agriculture, mechanic arts, natural sciences connected therewith, as well as a thorough course of instruction in all branches of learning upon agriculture and other industrial pursuits.

“SEC. 3. The course of instruction of the Agricultural College, Experiment Station and School of Science shall embrace the English language, literature, mathematics, philosophy, civil and mechanical engineering, chemistry, animal and vegetable anatomy and physiology, the veterinary art, entomology, geology, and political, rural and household economy, horticulture, moral philosophy, history, mechanics and such other sciences and courses of instruction as shall be prescribed by the regents of this institution of learning. * * *

“SEC. 5. That a commission of three be appointed by the governor, with the advice and consent of the senate, to select a site for the location of said Agricultural College, Experiment Station and School of Science, who shall locate said College and School of Science upon land selected with special reference to its adaptability for the purposes intended and not for its pecuniary value: *And provided*, That none of the commissioners

so appointed shall be from any county east of the Cascade Mountains: *Provided further*, That said commission shall not consider, receive or accept any bonus other than a tract of land not exceeding three hundred and twenty acres, and said commission shall locate said College and School of Science on or before July 1, 1891, in some county east of the Cascade Mountains." * * *

By the same act, section 11, the assent of the legislature of the State of Washington is given to carry out the provisions of the congressional acts called the "Hatch" and "Morrill" acts.

The locating commission met and organized at Olympia April 2, 1891. After the commission had visited and carefully considered the merits, the eligibility and natural advantages of the many localities in counties east of the Cascade Mountains, they made their report to the governor. The following paragraph is quoted from this report:

"The commission did, on this 25th day of April, 1891, meet at the city of Olympia, and after balloting, unanimously decided that said College, as above referred to, should be and is hereby located at the city of Pullman, in the county of Whitman, State of Washington, upon the following described tract, piece or parcel of land, containing two hundred acres more or less."

PULLMAN

Is eighty miles south of Spokane, and is located in the famous Palouse valley, in the southeast part of the state, and in the midst of the finest agricultural and horticultural region in the world; it has artesian wells of pure mineral water, and is very healthfully situated. The town is well supplied with churches, and has an intelligent, cultured and enterprising population; it is accessible from the south, west and east by the Union Pacific Railroad, and from the north, south and east by the Northern Pacific Railroad. The climate is all that could be desired. Its climatic conditions from year to year are not variable. There are, on an average, three weeks of snow. The total annual precipitation is about forty inches.

THE STATION FARM.

The College and the United States Experiment Station own a tract of two hundred and twenty acres of very choice and valuable land, consisting of valley, side-hill and table land.

The farm is about one mile east of the business part of the town. It is remarkably well adapted for horticultural, fruit and forestry experiments, for grazing and hay, for the culture of the various cereal grains and other farm products, for lawns, and for parks and campus.

The soil is of great depth and is inexhaustible, and contains those salts and silicates so essential to plant life. It is a sedimentary deposit, evidently of volcanic origin, as it is composed of a sandy loam, disintegrated basalt and ash. It is very porous and readily drinks in moisture and gives it out as needed, allowing the salts to rise to feed the growing crops. The farm is enclosed and the greater part of it is now under cultivation. During the past year it has produced good crops, consisting of wheat, oats, barley and rye. A one-story brick building 60 by 36 feet has been completed, at a cost of about \$2,500, which will be used temporarily for class purposes.

THE COLLEGE CAMPUS

Joins the farm on the west, and is beautifully located upon a commanding eminence which overlooks the town. From the upper bench of the campus can be seen in the clear air of this region, for miles in every direction, a beautiful, rolling prairie country, the wealth-bringing possibilities of whose agricultural and horticultural resources to the state cannot be overestimated, whose uniquely formed and picturesque hills and golden grain fields in all their wealth of varied beauty, with a dim outline of the Bitter Root Mountains and forest in the east and north, and the Blue Mountains in the south, form a panorama never to be forgotten.

ORGANIZATION.

At a meeting of the board of regents May 1, 1891, arrangements were made for the preparation of plans for the College buildings and the organization of the experimental work, as required by law. The board of regents formally took possession of the land selected by the locating commission May 22, 1891, and entered into active arrangements to immediately organize and equip the station, and to begin experimental work and com-

ply with the provisions of the "Hatch act;" also to open the College and organize the educational work of the institution. With this end in view building plans were adopted, and a contract for the construction of the present farm building was entered into. The regents were soon interrupted and prohibited by legal proceedings from executing their plans for the organization of the Station and College work.

The supreme court of the State of Washington has recently handed down an opinion on the legality of the questions at issue. This decision enables the regents to execute their plans and perfect the organization of the work as contemplated.

Preparations are completed whereby experimental and station work will be commenced early in the spring. Farming tools, machinery, stock, etc., sufficient to carry on all kinds of farm work are being arranged for. A topographical map of the College campus has been made. The lawns and walks will be laid out, ornamental trees and shrubs, arbors and parks will be planted.

Plans are completed for the purchase of an outfit of chemicals and physical apparatus, etc., for the chemical and physical laboratory, necessary for the analysis of waters, minerals, organic substances and other purposes; also, microscopes, spraying machines and equipment for the laboratory work in horticulture and botany; also, surgical instruments, models, skeletons and preserved pathological specimens, etc., for laboratory work in veterinary art; multiple sets of carpenters' and joiners' tools and wood-turning lathes, etc., for the work shops; blacksmiths' forges and necessary tools, engine lathe, iron planer, drill press, steam fitters' tools, an assortment of hand tools, etc., for the machine shop; surveyors' transit, compass, wye level, solar compass, chain, steel tape, rods, etc., for the work in surveying and engineering; a set of meteorological instruments; the latest and best scientific works of reference, books for aids in the various department work, as well as the leading literary, scientific and technological periodicals; typewriters, musical instruments, etc., for the light manual trades and accomplishments; sewing

machines, furniture and conveniences, etc., for work in domestic economy. Stress will be laid on the manual and industrial studies and occupations as constituting a distinguishing feature of the school. This will require a fine equipment of machinery, philosophical and laboratory apparatus. The nucleus of a library collection, consisting of books, pamphlets and publications for department work, is already secured.

During the summer, farm buildings and shops for wood and iron work will be completed; also, a dormitory in which 125 students can be roomed and boarded, will be erected and furnished. As soon as possible farmers' institutes will be conducted by the members of the station staff at the College and in different parts of the state.

PROPOSED TESTS AND EXPERIMENTS.

So far as circumstances will permit, Professor Lake will endeavor to make tests and experiments as follows:

HORTICULTURE.

1. Local and general tests of the older and newer varieties of all the hardy orchard and small fruits.
2. General and practical tests of cultural methods with reference to localities and soil.
3. The introduction and dissemination of the more promising fruits and nuts from foreign states, particularly Russia and Japan.
4. The improvement by selection and cross-fertilization of our native fruits.

BOTANY.

1. A systematic study, including an exhaustive collection, of the state's flora.
2. Local and general tests covering the introduction into cultivation of our native grasses, clovers and other forage plants, as well as the more promising ornamental herbs.
3. The establishment of a botanic garden wherein may be gathered, as nearly as possible, all the native plants of the state as well as some foreign ones.

4. The thorough testing of grasses and other forage plants for the arid sections of the state.

FORESTRY.

1. A general study of the forestal conditions of the state, with especial reference to forest preservation and tree growth.

2. The testing of native and introduced forest and ornamental trees in the treeless portions of the state.

3. The collection into an arboretum of all the native trees and shrubs of promising economic or ornamental importance.

It will be understood that the above is only a general outline of proposed popular work. Each section embraces many specific questions, such as, the selection of special varieties for particular localities and soils; irrigation, in so far as it relates to orchard and garden crops; deep and shallow cultivation; winter protection of tender trees and herbs; pruning; evaporation and other methods of preserving fruits, etc., etc. So far as the strictly scientific work of this division is concerned, no definite plan of action can be formed until further information is gathered relative to the horticultural and forestal needs and resources of the state, and until much necessary preliminary work is done.

All persons interested in this work and having in their possession some rare or little-known fruits, vegetables or ornamental plants, are earnestly requested to confer with the division relative to having the same tested on the College and Station grounds.

Contributions from nurserymen, seedsmen, collectors and originators will be gladly received and due credit given. Exchanges will be made when possible, and guarantees given originators that new fruits will be protected.

The results of station and experimental work will be announced in future bulletins.

The Agricultural College was founded in anticipation of the advantages to be derived from the land granted by act of congress in July, 1862. Under this act, each state then in the union,

and every one afterwards to be admitted, was granted a quantity of land equal to thirty thousand acres for each representative the state had or shall have in congress. The following is quoted from this act:

“All moneys derived from the sale of the lands aforesaid by the states to which the lands are apportioned, and from the sales of land scrip, shall be invested in stocks of the United States, or of the states, or some other safe stocks, yielding not less than five per centum upon the par value of said stocks; and the money so invested shall constitute a perpetual fund, the capital of which shall remain forever undiminished, except as herein provided, and the interest of which shall be inviolably appropriated by each state, to the endowment, support and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life.”

The “omnibus bill,” under which Washington became a state sets apart *ninety thousand acres* of land for the agricultural college, and *one hundred thousand acres* of land for the school of science as a perpetual endowment for these institutions. When these lands are sold and the proceeds invested, the College and School of Science ought to be independent of state aid for its current expenses.

THE HATCH ACT,

Passed by congress and approved March 2, 1887, provides that a *Government Agricultural Experiment Station* shall be connected with the Agricultural College, as a distinct department, and under the control of the general government; also that the Station shall receive an annual appropriation of \$15,000, and be distinct from the income of the College.

The advantages of this union between College and Station are manifold. Most members of the College faculty are at the same time members of the Station staff, engaged in conducting experiments and making researches in the various departments of agricultural science and practice.

The following paragraphs are quoted from this act:

“Be it enacted in the Senate and House of Representatives of the United States of America in Congress assembled, That in order to aid in ac-

quiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established, under direction of the college or colleges, or agricultural department of colleges in each state or territory established, or which may hereafter be established, in accordance with the provisions of an act approved July second, eighteen hundred and sixty-two, entitled 'An act donating public lands to the several states and territories which may provide colleges for the benefit of agriculture and the mechanic arts,' or any of the supplements to said act, a department to be known and designated as an 'Agricultural Experiment Station.' * * *

"SEC. 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective states or territories.

"SEC. 3. * * * It shall be the duty of each of said stations, annually, on or before the first day of February, to make to the governor of the state or territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said commissioner of agriculture and to the secretary of the treasury of the United States.

"SEC. 4. That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the states or territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same, and as far as the means of the station will permit." * * *

"SEC. 5. That for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results as hereinbefore prescribed, the sum of fifteen thousand dollars per annum is hereby appropriated to each state, to be specially provided for by congress in the appropriations from year to year, and to each territory entitled under the provisions of section eight of this act, out of any money in the treasury proceeding from the sales of public lands, to be paid in

equal quarterly payments, on the first day of January, April, July and October in each year, to the *treasurer* or *other officer* duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, eighteen hundred and eighty-seven: *Provided, however,* That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement or repair of a building or buildings necessary for carrying on the work of such station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

“SEC. 6. That whenever it shall appear to the secretary of the treasury from the annual statement of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station, in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

“SEC. 9. That the grants of moneys authorized by this act are made subject to the legislative assent of the several states and territories to the purposes of said grants.” * * *

THE MORRILL ACT,

Passed by congress and approved August 30, 1890, provides for the more complete endowment and support of colleges for the benefit of agriculture and the mechanic arts. Under this act the Agricultural College will receive from the general government \$15,000 for the first year, \$16,000 for the second, \$17,000 for the third, and so on until the annual amount reaches and remains at \$25,000.

The following paragraphs are quoted from this act:

“*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That there shall be and hereby is annually appropriated, out of any money in the treasury not otherwise appropriated arising from the sales of public lands, to be paid as hereinafter provided, to each state and territory for the more complete endowment and maintenance of colleges for the benefit of agriculture and the mechanic arts now established, or which may be hereafter established, in accordance with an act of congress approved July second, eighteen hundred and sixty-two, the sum of fifteen thousand dollars for the year ending June thirtieth, eighteen hundred and ninety, and an annual increase of the amount of such appropriation thereafter for ten years by an additional sum of one thousand dollars over the preceding year; and the annual amount to be paid thereafter to each state and territory shall be twenty-five thousand dollars, to be applied only to instruction in *agriculture, the mechanic arts, the English language, and the various branches of*

mathematical, physical, natural and economic science, with special reference to their applications in the industries of life, and to the facilities for such instruction. * * *

"SEC. 2. That the sums hereby appropriated to the states and territories for the further endowment and support of colleges shall be annually paid on or before the thirty-first day of July of each year, by the secretary of the treasury, upon the warrant of the secretary of the interior, out of the treasury of the United States, to the state or territorial treasurer, or to such officer as shall be designated by the laws of such state or territory to receive the same, who shall, upon the order of the trustees of the college, * * * *immediately pay over said sums to the treasurers* of the respective colleges or other institutions entitled to receive the same, and such treasurers shall be required to report to the secretary of agriculture and to the secretary of the interior, on or before the first day of September of each year, a detailed statement of the amount so received and of its disbursement. The grants of moneys authorized by this act are made subject to the legislative *assent of the several states and territories* to the purpose of said grants." * * *

"SEC. 3. * * * An annual report by the president of each of said colleges shall be made to the secretary of agriculture, as well as to the secretary of the interior, regarding the condition and progress of each college, including statistical information in relation to its receipts and expenditures, its library, the number of its students and professors, and also as to any improvements and experiments made under the direction of any experiment stations attached to said colleges, with their costs and results, and such other industrial and economical statistics as may be regarded as useful, one copy of which shall be transmitted by mail free to all other colleges further endowed under this act.

"SEC. 4. That on or before the first day of July in each year, after the passage of this act, the secretary of the interior shall ascertain and certify to the secretary of the treasury as to each state and territory whether it is entitled to receive its share of the annual appropriation for colleges, * * * under this act, and the amount which thereupon each is entitled, respectively, to receive. * * * And the secretary of the interior is hereby charged with the proper administration of this law."

The intent and purpose of these acts was to establish an institution which will provide such intellectual and moral training as will best fit the young men and women of the state for all the productive industries. With this end in view the following courses of study are now offered:

1. Course in Agriculture.
2. Course in Mechanic Arts.
3. Course in Domestic Economy.

The course in agriculture is designed for young men, and the

course in domestic economy for young women. The course in mechanic arts is for those young men who have tastes and talents for any of the mechanical industries. A short course in pharmacy, designed to prepare young men and women to become druggists, will also be offered. Also, a course in civil engineering will be added. Many of the light manual trades, such as stenography, typewriting, telegraphy, wood carving, photography, etc., will be offered to all, but is more especially designed for the benefit of such young women as may desire some means of support.

PREPARATORY DEPARTMENT.

For the benefit of those who are not far enough advanced in their studies to enter the college classes, a preparatory course of one year is offered. Any person fourteen years of age, who understands arithmetic and elementary English grammar, who understands geography, who can read and write with facility, and spell well, can enter the preparatory department at the beginning of the year.

The Agricultural College and School of Science will be opened on Wednesday, January 13, 1892. Tuition is free in all the departments of the College.

WASHINGTON AGRICULTURAL COLLEGE
AND SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 2.

REPORT OF FARMERS' INSTITUTE, HELD AT COLTON,
WASHINGTON.

JANUARY, 1892.

OLYMPIA, WASH.:
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STATION STAFF.

GEORGE LILLEY, PH. D., LL. D.,
Director.

JOHN O'B. SCOBEE, A. M.,
Agriculturist.

EDWARD R. LAKE, M. SC.,
Horticulturist and Botanist.

GEORGE G. HITCHCOCK, A. B.,
Chemist.

CHARLES E. MUNN, V. S.,
Veterinarian.

REPORT OF FARMERS' INSTITUTE,

HELD AT COLTON, WASH., JAN. 30, 1892.

The first of a series of Farmers' Institutes, which it is proposed to hold throughout the state under the auspices of the Agricultural College, was held at Colton on the 30th day of January, 1892, Mr. C. W. Richardson presiding, with E. E. Alton secretary. The following papers were read by the several members of the station staff:

THE PURPOSES AND AIMS OF THE WASHINGTON AGRICULTURAL COLLEGE.

SYNOPSIS OF THE ADDRESS

BY

PRESIDENT LILLEY.

I can do no more, in the few minutes assigned to me, than to attempt in a very brief manner to give a rough outline of what the purposes and aims of the College are. Primarily the purpose of the College is to teach, and I wish that idea might be enforced; I wish it could be understood by every farmer in the state who intends to send his boy and girl to the College. I fear that there are those who have a misconception of the work which the College is designed to do—a misconception of the purposes of the College. It is the purpose of the school to teach those of the rising generation and to prepare them for the industries, the responsibilities and the work of life. That institution of learning will do its work well when it equips the boy and the girl for the work which the demands of the future shall make upon them. The purpose of the College is simply to teach, and not to confine itself exclusively to the work of experimentation, investigation and research.

There is no educational value in the mere menial employment of following the plow and routine farm labor. The College does not require that a boy should be thus employed in order to be well

taught and to become an educated man. It is the duty of the College to teach, and primarily to teach those branches of learning which underlie and which relate to the art of agriculture, and those branches which underlie and relate to the mechanic arts. It provides courses of study for the discipline and furnishing of the mind, as well as technical and professional occupations and studies. Its aims are to give a substantial and practical education to young men and young women. It teaches the sciences, and applies them to the various industries of farm, shop and home. It covers such a course in the English language and literature as will insure reasonable skill and accuracy in speaking and writing the mother tongue, a taste for reading, and a knowledge of the use of books as instruments. It includes a good course in mathematics, surveying and mensuration, field practice with chain, compass and all the instruments necessary for practical surveying. It covers the outlines of general history, and the history of our own country, including the United States constitution, business methods, forms, laws and ethics. Chemistry and physics; shop practice in wood and metals, and the mechanics of farm machinery, with special stress laid upon laboratory work, are all made prominent means of teaching the mental faculties to quick observation and accurate judgment. Careful study of the plants, minerals and animals themselves serve to illustrate and fix the daily recitations in botany, mineralogy, zoology and entomology. It covers extended courses of instruction in mechanical and civil engineering. The College will also teach useful manual occupations, including pharmacy, printing, telegraphy, photography, taxidermy and plumbing, for the benefit of those who may desire to make any one of them his special trade.

The curriculum is so arranged that several different courses, each complete in itself, are offered. Those who pursue the agricultural course are required to take lessons in agriculture and horticulture, enforced by actual experiments, showing the application of science. A variety of studies are offered, and those who desire to do so can make a selection of subjects. In all its departments the College trains in the elements of the arts and endeavors to impart such skill as will make the hands the ready instruments of thoughtful brains. It trains the hand, the eye, the mind and the heart. It aims to give such general information and discipline of mind and character as will help to make intelligent and useful men and women and to keep its students in sympathy with the callings of the people.

A higher obligation rests upon it to train up true manhood and womanhood, than to train up a farmer or to train up a mechanical or civil engineer. It must not be forgotten, moreover, that it is the duty of the College, also, to train for citizenship.

The training of the shops, laboratories, gardens and farm is a part of a general education which leads to usefulness and at the same time insures a means of living to all who make good use of the opportunity. Such a training preserves habits of industry and manual exertion, and cultivates a taste for home and rural life. The industrials taught, or the subjects by means of which theory is put into practice, will require the time of at least an hour a day. These subjects, for the young men, include carpentry, cabinet making, work in metals, printing, telegraphy, stenography and typewriting, vocal music, farming, care and management of stock, gardening, fruit growing and tree planting, military drill, laboratory work, land surveying, irrigation, road building, etc. The industrials for the young women lie in the direction of the home-making arts and accomplishments—such as instrumental and vocal music, drawing, painting, sewing, dress fitting, cooking and serving food, household economy and sanitation, care of the sick, rural architecture, landscape gardening, floriculture, typewriting and stenography, telegraphy and printing. In short, the educational work of the industrial side of the College consists of *science with practice*.

DAIRY FARMING IN WASHINGTON.

J. O'B. SCOBEEY.

The time has arrived in the development of the agricultural resources of this state when the cow must begin to receive her proportionate amount of attention. Experience has taught us that under proper conditions and intelligent management there is no greater source of profit to the average farmer than that derived from the conversion of a reasonable amount of the product of his acres into table food in the form of butter and cheese.

From a very short period of observation and inquiry, I am led to believe that with the majority of farmers in Eastern Washington wheat raising is given more attention and is considered of more

importance, at the present time, than any other branch of farm industry.

I am quite willing to admit that a harvest of forty, fifty and sixty bushels of wheat to the acre is a temptation that has strong tendencies to lead most of us astray from a desire to be troubled with any other branch of farm work which is more laborious, which requires more attention to detail, and which on the face of the returns seems to render less profit than the raising of this magnificent crop.

To me there appear to be a great many reasons why our farmers should not give up all their energy to raising wheat, and I do not know that it is necessary for most of them to even reduce their acreage of wheat to, at the same time, enter into successful dairying. What I would complain of is, that any farmer should stop at his crop of wheat or other small grain, when he might at the same time operate at least a small but fairly well paying dairy.

However it may be with Washington, experience has taught us that all the older states have sooner or later been obliged to turn from grain raising to butter making. If Washington is an exception, it will be the first. Even the far-famed North Dakota wheat fields, which some said, even after analytical tests of the soil, would never fail to yield their full measure of "No. 1 hard," have at last been obliged to push aside the harvester to make room for the cow.

I don't ask you to lay aside your seeder and sickle, but I do invite you to consider the question now, and from this time on, whether the cow shall not receive a fair portion of your attention.

You can begin this year as well as next. How? you ask. I answer, with whatever material you have at hand.

An erroneous idea prevails with many that to begin dairying one must have a herd of thoroughbred dairy cattle. While that would be pleasant, it is not necessary by any means. Let every farmer begin with just what he has on hand. If you have a cow, I care not if she never even had an opportunity to eat grass in the same field with a blooded animal; no matter how "scrubby" you may consider her, give her a chance, under proper conditions with proper feed and handling, to show her dairy qualities before condemning her. She may be a valuable cow. If after a careful test she is not, then discard her at once. Don't keep a cow a minute in your dairy or on your farm unless she is bringing you profit. Test her frequently, keep a careful record and at the end of the year balance

up, and you will then know which cows in your herd are making you money and which are not.

While you may successfully start with the cows you have, or which for a small expense may be added to your herd, do not be satisfied to continue with any other than a thoroughbred registered bull at the head. Some think a good grade bull is good enough for them. A grade bull is a curse to any farm. Get a full blood, then your increase is all the time growing better instead of worse. You may start with a thoroughbred bull and a native cow and you can inbreed twice without danger of weakening the constitution of your herd. A fresh bull should then be introduced to the increase.

Some question has been raised as to the feed necessary to keep cows in proper form for dairy purposes. I have heard complaint that the grasses are giving out—especially the wild grasses indigenous to this locality, and that there is difficulty in securing a satisfactory growth of tame grasses; that therefore cows cannot be kept up in their milk.

Proper feed properly fed is a very important item in the successful operation of the dairy. Grass during the summer months is quite essential, and this station will make a special study of that subject, with extensive experimentation to ascertain if we can depend upon good and continuing pasturage. I think it can be accomplished. Cows in the dairy, however, should be given a grain ration during the summer, even when on good pasturage, if we would realize the best results. With the pasture advantages you now have, and a liberal grain ration, the milk and cream may be kept up. Such feed you can afford to use liberally for you raise it in abundance. Nothing is better than wheat bran and ground oats mixed in equal quantities. Both are here grown in abundance.

In the settlement of the question between wheat and butter, one of the first points to decide is the relative profit that may be realized from an acre of ground. In other words, year in and year out, will an acre devoted to the cow yield as much profit and do as much good to humanity as an acre devoted to wheat? This is the question we are called upon to settle.

I trust that the farmers of Washington will give this subject the careful attention it merits.

DISCUSSION.

THE CHAIRMAN: Mr. Barkhuff, will you give us your views on the subject of dairying—your experience?

MR. BARKHUFF: If we do any dairying in this section, we must change our entire system of farming. It now requires eight acres of our bunch grass to keep a cow. But bunch grass is about exhausted, and we must resort to some other material for pasture to feed our cows upon. As it is now, cows don't compare with wheat farming. I consider mixed farming the best system; that is, when I raise grain I think it better to raise oats and barley as well as wheat. No doubt this matter of testing each cow's milk is a good thing. I never tried it, and so don't know how profitable any individual cow I have kept has been to me. One trouble here is that our wild grasses put on fat instead of producing milk. Grain pasture at present is the best we have for cows.

PRESIDENT LILLEY: How many acres of grain pasture does it take to keep a cow?

MR. BARKHUFF: I do not know.

MR. SCOBEE: I agree with Mr. Barkhuff that if it takes eight acres of grass to keep a cow, the dairy cannot compete with the wheat field. We must produce enough on two or three acres to keep a cow before we can compete with wheat in this country. We shall experiment in this matter at the station and ascertain if it can be done.

THE CHAIRMAN: Mr. Ferguson, we should like to hear from you on this subject.

MR. FERGUSON: For two years I milked fifty cows, selling the milk here for cheese. I am satisfied if it were properly carried on it would prove profitable. The last year I sowed wheat for pasture, but it was a dry season and partly a failure. In an ordinary season I think I should have made money on it. I milked my cows eight months, and I think the yield per cow was about forty dollars. Many of them were inferior, but I had no way of finding out just which ones they were. If I could have picked out fifteen or sixteen of the best, I think they would have returned me about \$75 per head. As it was, I lost money at it.

PRESIDENT LILLEY: What breed of cows were these?

MR. FERGUSON: They were natives and grade Holstein. I had a Holstein bull.

MR. BARKHUFF: Our plan of milking is of the "nip and tuck" style. That is, we let the calf run with the cow so long that it is

hard to tell which gets the more milk during the year, the milker or the calf.

MR. RICHARDSON: I think we ought to take away the calf at once. One cow without the calf being left at her side is worth two after the calf has been allowed to run with the dam for any great length of time. As soon as the calf is old enough to digest ground feed, I should give it plenty of that.

MR. SCOBEY: I advise you all to test your cows frequently, by setting the milk of each separately. A cow that will not yield from 250 to 300 pounds of butter per year should be taken from the dairy, fed on your bunch grass and sent to the butcher.

THE TREE CROP FOR EASTERN WASHINGTON.

E. R. LAKE.

This great section of our state, known as the Palouse country, is remarkable wherever its resources are well known for its wonderful soil fertility, its rolling, broken surface, its treeless hills and vales, its wheat crop and its alkaline water. These characteristics, I say, are familiar to every one who has seen or heard of this section. But, fortunately, the list does not end when we have named the above. There are other deeper-lying peculiarities that with development are certain to bring forth industries that will out-shadow in significance king wheat of to-day. Man cannot live by bread alone is a divine injunction, and no less a physiological impossibility. To make this section the fit abode of many thousand people, as it may be, we must needs grow something else than wheat; and foremost among those crops that call for attention is the tree crop.

Between the Blue Mountains on the southwest and the Bitter Root on the east and northeast lies a vast stretch of wind swept, bleak, bald ridges, with intervening valleys, coves and glens. Portions of this ought to be covered with forest growth, thereby ameliorating these warm southerly winds (locally called chinooks) and the cold northerly winds. Forest areas have well known and marked influences on climate, modifying both the cold of winter and the heat of summer. There are many phases of this subject; but only two of especial importance face us just now, namely,

forest or shelter belts and orchards. The former we need for climatic and timber purposes, the latter for fruit and nut production.

The growth of forest belts has been favorably shown by numerous farmers who have within the past few years planted belts varying from ten to forty acres. And it is found that a wide range of trees make reasonable growth. For much of our section this phase of the subject is already settled, save perhaps in so far as coniferous trees are concerned. Most of the forest tree plantations to date are of deciduous trees. Some evergreens ought to be introduced. More and larger plantings ought to be made. Especially ought the nut-bearing trees to be represented in the forest plantations that two objects may be attained in one operation—timber belts and nut production.

In orchard planting we have even less done than with timber trees, save in the Snake river locality. For many years after the settlement of this Palouse section the people thought it impossible to grow fruit, but in the last decade, little orchards have appeared here and there throughout this territory, and now we have evidence sufficient that not only will this section produce good wheat but it will also produce good apples, pears, plums and all the small fruits. In places excellent peaches and other tender fruits are produced in abundance and perfection. This is well, for nature makes no mistakes. And here we have only another illustration of the eternal fitness of things. Our soil is rich in alkaline salts, or chemically stated, oxides of sodium and potassium. These substances are being leached out in greater or less quantities, by the dissolving snows of winter and the gentle rains of spring and fall. A no inconsiderable quantity of these materials find their way into wells and ponds whence man and stock obtain water. The continued use of such water tends to, and often does, overload the system with these salts, resulting in many acute and some chronic diseases.* This is a fact attested by many of our best physicians, and is, therefore, a weighty consideration in the subject. In view of this fact it behooves us to consider, advisedly, any proposition that promises relief from such evident danger. Fortunately nature has made provision for just such a condition of affairs. The substances which now, with a bread, meat and vegetable diet, are taken into our systems and work havoc in the form of fevers, gastric, kidney and liver troubles, may be counteracted by the use of

* See article by Dr. J. B. Pilkington, in *Fruits and Flowers* for September, 1891.

fruit acids. In other words, if we would increase our fruit diet and diminish our meat diet there would be less troublesome ailments among our people and greater physical hardihood.

With the numerous examples of successful tree growth before us, it is not difficult to draw most favorable conclusions regarding the future orcharding of this section. Our soil and climate are not unsuited for this industry, so far as the hardier fruits are concerned. The demand for fruit is present of necessity. The only question apparently unsettled is the one of financial profit.

The period of "first fruits" is past, for small orchards have been bearing for several years in various parts of this section, and with few exceptions the results have been most flattering, for be it understood that scarcely one in a score of those that are bearing today have received ORCHARD CULTURE. In nearly every instance they have been planted and cared for much as a wheat crop would be. A hole has been made in the ground, the trees stuck in, roots covered, and the crop watched and waited for. And it has come, regardless of the fact that the trees have fought their own battles, and conquered their own foes without the fostering care to which they are entitled and which they must receive from the cultivator if the best results are to be attained.

As to the preparation of the land we can offer but little. It should be deeply plowed, subsoiled if the surface soil is underlaid at no great depth with an impervious stratum, as I am led to believe some of this land is, and thoroughly pulverized.

Plant only those varieties which have already proved hardy or which you may have reasons to know will likely prove so. In the latter case it may be well only to plant a few. In this matter of selection the College hopes to be of some service later on to the orchard and garden planters, not only of this section, but of the state, as it is expected to have extensive varietal tests carried on in various portions of the state.

Any plantation of trees, whether for orchard or forest purposes, must be well cultivated from the beginning if returns at all satisfactory are desired. Unlike wheat growing, tree growing will not take care of itself and give first-class returns. Trees need constant care and study to give the best results.

Though orchard planting may appear to demand our first attention under these circumstances, we must not lose sight of the fact that large forest plantations would avail much benefit in ameliorat-

ing the climate, especially in so far as the high winds are concerned. Tree planting for windbreak and forest purposes is, in fact, among the first steps we should take in this much needed work.

DISCUSSION.

MR. BARKHUFF: Orchards and fruit can be successfully raised in this section. I find that apples, plums, pears and cherries do well. Peaches do not do so well. They will produce an occasional crop, but owing to late spring frosts the trees soon perish. Twelve years ago I planted an orchard on top of a hill exposed to our southwest winds. This orchard has now given me crops for five years without a failure, but on the side of the trees exposed to the winds very little fruit has been produced, and in fact the trees are only partially developed on that side. With windbreaks I think this would largely be prevented. The only serious trouble we have to contend against is the pocket gopher. We have no green aphid, woolly aphid or San José scale. Three years ago we had some trouble with worms in the fruit, but that year I mulched the trees liberally with straw and allowed the chickens to run in the orchard, and since then my fruit has not been troubled with worms. I think the worms in transforming were in the straw, and as the chickens scratched around they found them and ate them.

MR. LAKE: Is not the outlook good for seedling fruits raised and propagated here?

MR. BARKHUFF: Yes; I have raised a seedling pear from the Fall Butter, which I have named the Washington. It is larger, rounder and firmer than the Fall Butter, with fully as good flavor.

MR. LAKE: What varieties of fruits have you?

Apples.—Twenty Ounce Pippin, Yellow Newtown Pippin, Red-cheek Pippin, Gravenstein, Winesap, Gloria Mundi, Red Astrachan, Red June, Early Harvest, Grindstone Pippin, Hubbardston Nonesuch, Northern Spy, Seek-no-Further, Spitzenberg, Grover Cleveland.

Crabs.—Transcendent, Hyslop, Whitney.

Pears.—Bartlett, Seckel, Vicar of Winkfield, Washington, Fall Butter, Sugar.

Cherries.—Royal Ann, Olivet, Governor Wood.

Plums.—Bradshaw, Coe's Golden Drop, Imperial Gage, German Prune, Peach, Washington.

MR. SCHULTHEIS: I am raising apples, pears, plums, prunes, and small fruits. I have the best success in grafting the hardier varieties that we raise here. My orchard is on flat land in a cove sheltered from all winds. I cultivate it thoroughly.

MR. LAKE: Do you grow any crops in it?

MR. SCHULTHEIS: No; I give it clean culture, stirring the soil as late as August first.

MR. LAKE: Are you troubled with the codlin moth?

MR. SCHULTHEIS: No.

MR. LAKE: Or the green or woolly aphis.

MR. SCHULTHEIS: No.

MR. LAKE: Do peaches winter-kill?

MR. SCHULTHEIS: They may blossom several times, but early frosts kill the blossoms, and after a time the trees die.

MR. LAKE: Are you troubled with bark-bursting?

MR. SCHULTHEIS: No; but the trees scald on the southwest side in summer, but I overcome this by heading low.

MR. LAKE: Do all kinds of small fruits do well?

MR. SCHULTHEIS: Yes; they grow in abundance.

SPASMODIC AND FLATULENT COLIC.

CHAS. E. MUNN.

All persons who have had much experience with horses are fully aware that colic is one of the diseases with which they are most frequently afflicted. Indeed, every stockman, farmer, liveryman, even down to the hostler, has an infallible specific for this disease, and will tell you with the greatest confidence imaginable that there never existed a case of colic his formula would not cure. It is very true that some of these remedies are very useful, others are of no account whatever, while the majority are positively injurious and have without doubt caused the death of many a valuable animal that might have made a good recovery without any medical treatment whatever.

There is every reason to believe that the nature, causes and proper treatment of this disease are not understood by the great majority of horse owners, and we will discuss from a scientific standpoint in as simple a manner as possible. The first question to consider is, What is colic? There are two kinds described—spasmodic and flatulent. Spasmodic colic is a painful abdominal affection, a spasmodic contraction of the muscular coats of the intestines, which may proceed to inflammation. Its causes are predisposing and exciting. In some horses certain kinds of food have a tendency to produce irritation of the alimentary canal. As in man, there are certain individual idiosyncrasies manifested in regard to certain foods. So it is to a certain extent with horses. Some horses are predisposed to diseases of digestion through habits of gross feeding, devouring their bedding and other filthy material which they may happen upon.

Some do not masticate their food properly, bolting a feed of grain in a few minutes that requires a much longer period to properly prepare for the digestive process.

The exciting causes are many. Sudden changes of food, exhaustion from overwork, especially when the animal has been some time without food, combined with a drink of cold water, will often produce this disease. Damaged food and excessive quantities of food given when the system is exhausted, the vital energies being, as it were, tired out, the process of digestion is arrested to such a degree that the food instead of being digested and yielding its nutrition to the system and gradually passing out of it, is detained and acts as an irritant to the structures in which it is detained. Chemical changes take place which by producing gases distend the parts involved, causing much distress and danger to the animal and producing what is commonly known as flatulent or wind colic.

The symptoms of colic most of us are familiar with. The animal becomes suddenly uneasy, appears to have a sudden cramp or gripe of pain; if in the harness will stop and attempt to lie down; when out of the harness will paw with the front feet, stamp the ground and kick at the belly with the hind feet, look anxiously around at the flanks, become wet with sweat, throw itself down and roll for awhile, and then perhaps suddenly jump up and remain quiet for some time, apparently free from pain, and in some cases entirely recovered. In the majority of cases, however, the symptoms return; he again becomes restless, walks around the box if

loose, begins to paw and throws himself suddenly to the ground. These recurring paroxysms may continue for some time, gradually becoming less severe and with longer intervals between them, and finally cease altogether, the horse resuming his normal condition, or they may become more severe and of longer duration, various complications ensue, as inflammation, rupture of the intestinal walls, or death from pain and exhaustion will ordinarily end a case of unrelieved colic.

These are the more common symptoms of ordinary colic, though there are some others, as in some cases detention of the urine from the muscular structure of the bladder being affected similarly with that of the bowel, and until relieved, its function is arrested. The pulse and temperature, except at the height of the paroxysms, are rarely altered, unless in protracted cases and those affected with complications. In flatulent colic where there is undue distention of the abdomen the breathing is much affected, the distended intestines pressing upon the diaphragm, and so lessening the capacity of the thoracic cavity that the lungs are unable to expand; the system does not receive its necessary supply of oxygen, and unless quickly relieved, the animal dies of suffocation, or it may be, in some cases from rupture of the bowel or diaphragm.

In regard to treatment, I may truly say that there is probably no diseased condition of the horse in which the treatment is more varied, the modes more opposite or greater in number, while it is surprising to note that they all have facts and evidence brought forward in support of their success sufficient to warrant their trial and adoption. We find in practice, that in treating cases of colic, the better plan is not to adopt any one line of treatment, or have any particular hobby in regard to any certain medicine or prescription, but to use what knowledge we possess of the physiological action of the digestive tract, and of the medicines which should be used to relieve the suffering of our patient. Such a course having been successfully pursued, our final endeavor should be to prevent the return of the disease.

In the more simple and uncomplicated cases, indicated by uneasiness and slight abdominal pain, the administration of a simple combination of an anti-spasmodic, an anesthetic, or even careful management in regard to diet, work and shelter, will bring many cases into a normal condition with but little or no medicine. In the more serious cases where we deem it expedient to evacuate the

bowels of their contents, and so remove the cause of irritation, a full dose of aloes is given in the form of a bolus or pill; this with injections of tepid water forms a very desirable and effective evacuant. In addition to this, in cases where pain is distressing, it should be relieved as soon as possible by the administration of from one to two ounces of tincture of opium combined with an equal quantity of spirits of nitrous ether in half a pint of warm water, or for the ether substitute an ounce of spirits of turpentine. Another useful formula would be aromatic spirits of ammonia three or four ounces, tincture of belladonna one ounce, with fifteen or twenty drops of tincture of aconite. If the abdomen should be distended by gases, give carbonate or bicarbonate of sodium in one-half ounce doses, or one-half ounce of aqua ammonia, one ounce spirits of turpentine in eight ounces of linseed oil (raw).

The surest and quickest method of relieving the distended bowel is to tap or puncture it at the most distended part with an instrument made for that purpose. This operation should be performed on the right side, and always by a person thoroughly acquainted with the anatomy of the parts.

This operation, if performed early and assisted by the evacuants mentioned above, has proved very successful treatment.

It is very essential to success in treating cases of colic that the treatment should begin early, before the animal becomes exhausted and before complications occur to render treatment more difficult.

During the attack the animal should be kept in comfortable quarters and prevented, as much as possible, from rolling and throwing himself, and thereby rendering himself more liable to injury from rupture of the diaphragm, or entanglement and rupture of the bowels.

DISCUSSION.

MR. SCOBEY: If I were ten miles from the office of a competent veterinarian and had a horse attacked with colic, and had none of the medicines you mention at hand, is there any treatment I could administer that would relieve the animal or prevent more serious complications, until I could secure the aid of the veterinary surgeon—a sort of emergency treatment?

DR. MUNN: It would be difficult for you or the veterinarian to treat a patient satisfactorily without any medicines. In an emergency one might give injections, nearly every house has a syringe. A dose of ordinary baking soda with a solution of red pepper would

help if the animal is bloated; also could give from a pint to a quart of raw linseed oil with an ounce or so of turpentine. Every one with valuable horses and living some distance from a veterinary surgeon should have a few simple remedies on hand.

MR. JOHNSON: Would a large dose of red pepper be likely to kill a horse? I know of an instance where a horse died in fifteen minutes after having been given a big dose of red pepper.

DR. MUNN: It is not likely the pepper killed the horse. Even a large dose is not likely to do that. The horse would have probably died just the same without it. I have seen a horse die very shortly after getting a dose of harmless medicine.

MR. N. T. SHIRLEY: Would bleeding cure a case of colic?

DR. MUNN: Not likely to do any good; better off without it.

MR. FERGUSON: Would it do to use boiled linseed oil?

DR. MUNN: Never use boiled linseed oil. You could use castor oil. These remedies I have mentioned would do no harm, at least, and might be of assistance until more effective treatment could be procured.

ATTENDANCE.

The following persons were in attendance:

B. J. Wiggins,	Colton.
Charles Cook,	Colton.
W. J. Davis,	Colton.
John M. Maynard,	Colton.
James Wiley,	Colton.
Walter Kelley,	Colton.
C. W. Richardson,	Colton.
M. A. Ferguson,	Colton.
Dr. McCollum,	Colton.
J. L. Flowers,	Colton.
Geo. W. Barkhuff,	Colton.
W. D. Barkhuff,	Colton.
Mr. Leisure,	Colton.
W. P. Murphy,	Colton.
Joseph Kirshner,	Colton.
Wm. Smith,	Colton.
E. E. Alton,	Colton.

W. W. Renfro,	Colton.
Thos. Gaston,	Colton.
James Sewalt,	Colton.
Al. Rooks,	Colton.
W. W. Parks,	Colton.
W. F. M. Ricketts,	Colton.
John Boyles,	Colton.
Chas. Kerns,	Colton.
Lafe Elliott,	Colton.
John Enstler,	Colton.
John Kramer,	Colton.
Geo. Story,	Colton.
J. W. Ceaser,	Colton.
J. B. Watson,	Colton.
Alex. McNevan,	Colton.
N. T. Shirley,	Colton.
Riley Standley,	Colton.
James E. Duff,	Colton.
John Black,	Colton.
Adam Black,	Colton.
S. J. Courtney,	Colton.
Miss Kate Camp,	Colton.
Mrs. Hugh Barnett,	Colton.
Prof. O. Mattoon,	Colton.
Lew Wiggins,	Colton.
Bernard Wiggins,	Colton.
Mr. Blatchley,	Colton.
Benj. Taylor,	Colton.
William Richardson,	Colton.
Miss Mary Maynard,	Colton.
Frank Harper,	Colton.
Thos. Winsted,	Colton.
Frank Richardson,	Colton.
John Shrader,	Colton.
Frank Moras,	Colton.
Andy Maxwell,	Johnson.
J. J. Johnson,	Johnson.
Mrs. J. J. Johnson,	Johnson.
Mr. Schultheis,	Uniontown.
P. E. Paradis,	Uniontown.
Mr. Shammer,	Uniontown.
James Warfield,	Asotin.
H. W. Baum,	Pullman.
E. Q. Merriman,	Pullman.



STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 3.

REPORT OF FARMERS' INSTITUTE, HELD AT GARFIELD,
WASHINGTON.

FEBRUARY, 1892.

OLYMPIA, WASH.:

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STATION OFFICERS.

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ANDREW H. SMITH, <i>Treasurer</i> ,	Tacoma.
HON. EUGENE J. FELLOWS,	Spokane.
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GEORGE W. HOPP,	Sedro.
GOV. E. P. FERRY, <i>ex officio Advisory Member</i> ,	Olympia.
<hr/>	
GEORGE LILLEY, <i>Secretary</i> ,	Pullman.

STATION STAFF.

GEORGE LILLEY, PH. D., LL. D.,
Director.

JOHN O'B. SCOBEE, A. M.,
Agriculturist.

EDWARD R. LAKE, M. SC.,
Horticulturist and Botanist.

GEORGE G. HITCHCOCK, A. B.,
Chemist.

CHARLES E. MUNN, V. S.,
Veterinarian.

ASSISTANTS.

EDWARD J. CHEATHAM,
Foreman of the Farm.

ROBERT JOYNT,
Teamster.

E. QUIMBY MERRIMAN,
Mailing Clerk.

REPORT OF FARMERS' INSTITUTE,

HELD AT GARFIELD, WASH., FEB. 20, 1892.

The second institute of the present series convened at Garfield, Whitman county, Saturday, February 20. President Lilley called the meeting to order, whereupon Senator R. C. McCroskey was elected chairman and A. S. Beach secretary.

The chairman, in announcing the object of the meeting, stated that the Agricultural College faculty were present to discuss with others various subjects of interest to the farmer, and also to explain the objects and workings of the College. The farmers were present to aid in the consideration of the subjects to be discussed. In the consideration of topics of interest to the Palouse section these gentlemen desire to learn all they can about our peculiar soil and climate, and we trust all will aid in this commendable work by shedding whatever light they can on the questions asked and points discussed.

Following a choice vocal selection rendered by the home choir, the following subject was first considered:

GOVERNMENT AID FOR THE COLLEGE.

EXTRACTS FROM THE ADDRESS
OF
PRESIDENT LILLEY.

The Agricultural College, Experiment Station and School of Science is both a state and a national institution. It was organized by an act of the state legislature, approved March 9, 1891, accepting the provisions of the congressional acts of 1862, 1887 and 1890.

The act of 1862 provides for a perpetual endowment, which is to be obtained from the selection, location and sale of the public lands of this state; also, that the money derived from the sale of these lands shall be invested in stocks of the United States or of this state, or some other safe stocks, yielding not less than five per cent. per annum upon the par value of the stock. The money so invested must constitute a perpetual fund, the

capital of which must remain forever undiminished. Only the interest of this capital can be used for the endowment, support and maintenance of the College. This perpetual endowment was fixed by the congressional act under which Washington became a state at ninety thousand acres of land for the Agricultural College, and one hundred thousand acres of land for the School of Science. The same act also provides that these lands cannot be sold for less than ten dollars per acre. These are considered extremely low figures for the value of the college lands, and those who are informed on the subject estimate a fair valuation to be several times these figures. The endowment secured by the act of 1862 is for the exclusive purpose of teaching or imparting information already acquired.

The act of 1887, called the "Hatch Act," provides for the establishment, support and maintenance of a Government Experimental Station to be connected with the College.

The Experimental Station is under the direct supervision and control of the federal government. The annual payment, secured by the act of 1887, is to be wholly devoted to the acquisition of information and in research. This research is to be in the field of agriculture and in the sciences which underlie and are directly related to agriculture.

The United States government makes it the duty of the station to conduct original researches and verify experiments on the physiology of plants and animals; the diseases to which they are subject and the remedies for the same; the chemical composition and analysis of plants, soils and water; the advantage of rotation in the growing of crops; the capacity of new plants and trees for acclimation; the adaptation and value of grasses and forage plants; the chemical composition of manures with experiments to test their effect and value on crops of different kinds; tests on the several varieties of food for domestic animals; experiments involving the production of butter and cheese, and such other tests and experiments bearing directly upon the agricultural and horticultural industry of the state as may be deemed advisable.

By the terms of this act the station secures an annual appropriation of \$15,000, which must be kept distinct from the income of the College. The Station is now in possession of \$11,250 of this amount for the present fiscal year.

The act of 1890, called the "Morrill Act," provides for the more complete endowment and support of the College for the benefit of agriculture and mechanic arts. The annuity secured by this act can be applied only to instruction in agriculture, the mechanic arts, the English language, the various branches of mathematics, physical, natural and economic science, and to the facilities for such instruction.

Beginning with the present fiscal year, and by the provisions of the Morrill act, in addition to the endowments as provided for by the acts heretofore mentioned, the College will receive \$15,000 annually, which amount is to be increased each year by \$1,000 until this annual appropriation reaches \$25,000, at which amount it remains at the pleasure of congress.

At present we have received none of the funds provided for by the Morrill act, but we have complied with the requirements of the law, and we have every reason to believe that our College will receive the appropriation for its first fiscal year on or before the first day of next July.

DISCUSSION.

MR. McCROSKEY : What buildings has the College ?

PRES. LILLEY : At present there is one brick building that meets our present needs quite well, and the board of regents have recently let the contracts for building and equipping a dormitory, the dimensions of which are 57 feet by 100 feet and three stories high. This building will be heated by steam and lighted by electricity. It is the further intention of the board to let contracts for the erection of a boiler and engine house, farm house, and barn and plant houses; also shops in which our students will receive instruction in wood and iron work. All of these buildings will be completed and thoroughly equipped during the summer months.

THE SUGAR BEET.

C. A. GWINN.

When Napoleon Bonaparte was having his little difficulty with England, he conceived the idea of manufacturing sugar from beets, that he might exclude the British West India sugar from France. The idea was new, and, as innovations of all kinds have ever been from the time Noah set about to build his ark, was ridiculed by the self-complacent wiseacres of the land. The *Puck* and *Judge* periodicals of that day caricatured the emperor. He was represented as seated at his breakfast in the act of squeezing a huge beet into his coffee. Near by sat his infant son, industriously chewing at a beet root. The nurse kept telling him to "Suck it, dear; suck it. Your father says it's sugar."

But Napoleon proved his indifference to these sarcasms by offering a bounty on sugar produced from beets within his empire. From this period dates the beginning of the industry, of which Napoleon may properly be called the father.

In the United States the production of sugar from beets is an infant industry, and of its vast extent and importance in the eastern hemisphere little is generally known. It will be a surprise to many to learn that in the world's production for the past five years the amount of beet sugar

produced exceeds that of cane by more than 1,000,000 tons. France and Germany are the chief producers of this commodity. The cultivation of the sugar beet seems to have become more popular in these old countries than in this, for several reasons. Our proximity to the sugar cane districts has rendered it less imperative than with them. There the individual farmer controls but a few acres, which it is necessary to make yield the greatest possible returns. The American farmer seems to have a rapacious desire to scratch over as many acres as possible, and seems to regard any suggestions of gardening as the circus elephant might be supposed to feel when required to pick up pins for the amusement of the crowd. Cultivation as well as seeds may be spread out too thinly. It is evident that the economical French farmers find sugar beets their most profitable crop, or they would not grow them. Now, if it pays them it ought to pay us two-fold. They have to pay a government tax on all beets raised; we are offered a liberal bounty on every pound of sugar produced. They often expend from \$20 to \$50 per acre for fertilizers; nature gave the Palouse country farmers a garden of inexhaustible fertility. We can add the cost of the Frenchmen's fertilizers to our profits.

If there is a more profitable crop than wheat we want to know it. Let us consider the crop under discussion from this standpoint. Sugar beets yield at the rate of from twenty to thirty tons per acre. The value is determined by the percentage of sugar contained, \$5 per ton being a fair average. At this rate we have a return of from \$100 to \$150 per acre. That this is not an exaggerated estimate is shown by the report of the California sugar beet producers for last season. They report that their crop has netted them \$75 per acre clear of every expense. What possibilities this industry opens up for this country! Were we to turn our attention to raising sugar beets, forty acres would require as much work and yield as much profit as a quarter section does now. And if it yield as much profit why should it not be worth as much? Let us picture the country around Garfield wholly engaged in producing sugar beets. Instead of one family to the quarter section there are four. Instead of land being worth \$25 an acre it is worth \$100. Instead of walking a half mile on a wet day to visit a neighbor and talk over crops, Farmers' Alliance and the third party movement, it is only forty rods. The whole country would be like a thinly settled city. Schools and churches would multiply, and the locality would become notoriously wealthy, offering advantages for culture and education that we do not now possess.

The successful production of sugar cane belongs exclusively to the warm climate of the south. The sugar beet grows to perfection only in northern latitudes. To be profitable for manufacturing purposes the beet should contain at least twelve per cent. of sugar, according to the agricultural department reports. In some localities the vegetable may flourish and yet lack the essential property. It requires peculiar climatic conditions and soil. It requires cool summers. Excessively warm weather saps the sugar-making element from the plant. And it requires a deep, fertile loam. In short, a description of the soil and climate best adapted to the production of the sugar beet is an accurate description of

the soil and climate of the Palouse country. Tests made from beets grown in Eastern Washington go to prove that this is the case. Of three different lots sent to the agricultural department in 1890, the report showed a percentage of sugar of 12.60, 14.96 and 15.37, respectively. In the report for 1891 Washington stands at the head of the list, the percentage being 14.75. Oregon comes next, but nearly one per cent. lower, showing that while the northwest excels, the Palouse country is as a bright spot on the sun's disc.

The agricultural department defines the sugar beet territory in the United States as a belt about 200 miles in width, commencing on the Atlantic coast at New York and following the course of the isothermal lines to the Pacific coast. Here is another evidence in our favor—the isothermal line that passes through New York, after much meandering, crosses Eastern Washington.

There seems to be but one impediment to the Palouse farmer immediately launching into a new and lucrative employment. The factory necessary to convert the sugar beets into sugar is costly. A plant for this purpose is estimated to cost from \$75,000 to \$200,000. But it will only be necessary to bring to the notice of capitalists and sugar manufacturers the superior quality of the Washington grown beet, and factories will come. It is only a matter of time. I will assume the role of prophet and predict that the present generation will see the Palouse country sown to beets. When the land now necessary to feed and clothe one person will better feed and clothe ten, and the imperfect pen-picture presented to you in this sketch will be verified. When the midday sun shall bestow its all too lavish blessing upon the upturned and perspiring backs of thousands of beet growers, and the autumnal echoes shall resound to the ominous thud of the mammoth sugar beet as it alights in the wagon that is to convey it to the factory.

DISCUSSION.

MR. LAKE: In the paper just read we have heard of mammoth sugar beets. I would like to ask Mr. Gwinn how large such beets would be?

MR. GWINN: Not very large, for the sugar beet is a small root compared with rutabagas and mangel-wurzels.

MR. LAKE: Is it not generally advised that the sugar beet be grown only to an average size, for best results?

MR. GWINN: Yes. Beets weighing about two pounds give best returns.

MR. McCROSKEY: From what part of Eastern Washington were the beets sent to the national department of agriculture?

MR. GWINN: Two lots were sent from Oakesdale and one from Medical Lake.

MR. SCOBEE: What varieties gave the results referred to?

MR. GWINN: No particular varieties stated. There are very many varieties under cultivation, but under mere test culture, as such cases as the above, the testers are not likely to put much stress on the variety. One important point was overlooked in the paper, and that is with reference to seed-growing. It takes about one-fourth as much acreage to produce the seed for the subsequent crop as is under cultivation for sugar each year.

MR. SCOBEE: In the figures just given us there is nearly three per cent. difference in the sugar percentage. This would seem to indicate varietal or soil differences of no little significance, for such a wide variation would make all the difference in profit and loss. Is it not probable that the same variety may be equally profitable on all our soils?

MR. GWINN: Yes; I think when the subject of beet culture comes to be seriously considered by our soil-tillers, varieties will be one of the first detail problems to be settled.

PRESIDENT LILLEY: What per cent. is considered profitable?

MR. GWINN: Twelve per cent. But, although some states give even a higher percentage than this, beet-culture in them is not considered profitable, as the crop one year with another is not reliable. At present we need to have a great many reliable analyses made of beets from the various localities, after which very definite information will be in our possession and we may then engage in the cultivation of this crop with the probable profit well understood.

PRESIDENT LILLEY: I think I may safely say that the College will be thoroughly equipped to do work of this nature for you this year and all subsequent years. This is a question of great importance to our state, and the College will endeavor to be ready at all times to render aid in solving such questions as our soil-tillers may refer to it.

MR. GWINN: Soil and climate alike affect the rate per cent. of sugar in beets. There are poor beet soils as well as poor wheat soils. The highest percentage given, so far as I have been able

to learn, is from Colorado for 1889, when beets from that state gave a return of nineteen per cent.

MR. McCROSKEY: The leading beet sugar section of California gives a return of fourteen per cent. In this section the growers find that certain soils will not give profitable returns. The best soils there are the same as ours, and it would seem that all is in our favor in the cultivation of this crop.

FARM DAIRYING.

J. O'B. SCOBEY.

Very few people in this or any other state are farming exclusively for pleasure; nor are they engaged in that healthful occupation entirely for "hygienic reasons." It is principally a question of profit. To be sure, we all find pleasure in the work of the field, the growth of the crop, the care of the dumb yet intelligent animal, the culture and the harvest of the fruit. But that pleasure is the pleasure that one feels in carrying out the work of his own selection. It is the pleasure of a feeling of duty done and of ambition gratified. The ultimate purpose of our work is to derive the profit which will enable us to enjoy the comforts and privileges of home, of society and of government. We seek that remuneration for our toil that will eventually render us comfortable and temporally happy.

With the intelligent, thinking, studying agriculturist, such as we are meeting with in this institute work, it is not a question of amount of profit that may be realized this year, irrespective of the possibility of future returns, but his farming is a question of what is the best policy to pursue this year, and which shall at the same time be consistent with the hope of production next season as well as for many years to come.

There is no field of labor, professional or otherwise, where intelligence counts for more than it does on the farm. The old notion that "anybody can run a farm" is all right if that "anybody" proceeds to his work with intelligence. If he does not, he may be the best educated and brightest man in the world and he will fail. It requires more intelligence to farm properly, that is, the employment of more intelligent judgment, than it does to build a house, edit a newspaper, or try a lawsuit. "Hap-hazard" farming never did, does not now nor ever will return a profit. Therefore, I say, the intelligent farmer, and consequently the best farmer, will go about his work with care and circumspection, inquiring what is best to do, not for a return of profit this year, but for this year in connection with next and succeeding years. Now, if I knew who is the poorest farmer in Washington, and by poorest I mean the least intelligent,

the one who reads little and thinks less (and I have no doubt he would likewise be the poorest in purse), if I could run across that man I would ask him if there is any intelligence displayed in raising wheat year after year, continually sapping the life and vitality of the soil, and at the same time giving nothing back. He must answer me in the negative. I would ask him if there is much wisdom manifest by a general community of farmers who will permit all the best butter buyers of their home market to import all their butter from Iowa, Wisconsin and Illinois, and pay forty cents per pound for it. If he could not answer that question, then I would be willing to accept the answer of this more intelligent assemblage. Many of the largest and best butter buyers of this country, to my certain knowledge, are buying butter from the states I have named at the price mentioned. Now, stop and figure on that a moment. A reasonably good dairy cow will produce, with proper feed and proper care, 300 pounds of butter in one year. That butter at forty cents per pound will yield \$120. Now, shrink your price for safety to thirty cents per pound and a 300-pound producing cow will yield a gross income of \$90 per year. That is in butter, with the skim milk left, which can certainly be utilized to make the amount up to \$100. If, then, we are farming for profit, and not for pleasure, and if we desire to exercise a reasonable intelligence as to what is best for to-day and for the future, is it not time to commence to combine dairying with other branches of farm industry? Wheat alone will as surely exhaust the soil of Eastern Washington as we continue to raise it, unless we return to the earth the elements that the growing grain extract from it. This is a new and rich country, and to many the truth of this proposition does not seem possible. But true it is. Therefore, those who have homes on these fertile prairies and who are building for the future, should be wise before it is too late to use wisdom.

I desire it to be understood that I am addressing my remarks to the home-builder—the man and the woman who are here to stay, and who are building for themselves and their children. The “scalper” will not be interested in this subject. The scalper is a man who is engaged in getting all there is in it to-day, and who will pull up stakes and be gone to-morrow. He has little care for the good of the community, or of the country. But you who are building up beautiful homes and trying to lay up profit for the future cannot afford to “scalp” the land, or fail to look carefully and intelligently in the direction of what is to come.

There is nothing that will be so important a factor in the future in adding profit to individual farming or in enriching this agricultural region, as dairying. The cow takes nourishment from the soil, but she turns in her profit to her owner, and gives back to the earth much of the richness which she absorbed.

It is not intelligent farming to wait until it no longer pays to raise wheat, or until it will not grow, before we begin dairy operations. We will then be too poor to commence. The time to begin is now, when the richness of the soil for wheat culture gives us a surplus to start in the dairy.

I don't want to see the wheat fields of this country forsaken. Bread is just as essential as butter. It is largely by reason of the former that we use the latter.

Now, two things are essential before farm dairying can be made a success:

First: It is necessary to definitely determine that we shall devote a fair part of our farm and of our time to this branch of agriculture.

Second: It is necessary to make suitable preparation.

The first proposition is a self-evident one. A success cannot be made of any undertaking unless it is entered into with spirit and enthusiasm. Half-heartedness never pays. I want to see the home-builders of this state awake to the realization of the importance of this matter of dairying, and then I want to see it entered into with a determination to make it stand shoulder to shoulder with the wheat industry. When the facts in regard to its importance and profit are fully understood the first desideratum will have been attained.

The question of making a suitable preparation is an important one.

To realize a profit from dairying we must have profitable dairy cows, and some conveniences for proper butter making. The most essential, however, is the right kind of stock. There is many a farmer in this country who is milking cows and making his own butter, that is the butter which his family consumes. He feels quite self-satisfied that he is doing that. Now, I will guarantee that if you will produce me a fair sample of all the milk from these cows, I will prove that three-fifths of these farmers would save money by selling the cows and buying the forty-cent Iowa butter.

At the same time a fair percentage of our common cows will do admirably for the dairy.

One of the first things, then, to do, is to separate our cows and keep only the profitable ones.

This work can be done at once. It may be begun this season as well as next. And while we are determining which are the profitable cows, we can, by properly kept records, determine how much it requires to keep a cow a year. When we know these two facts, the cost of a particular cow's keep and the amount of her income, we will know at once whether to milk her or fat her. In this way we can, in a season or two at most, make our selection from the stock on hand, and then, by the infusion of pure dairy blood into our herds, we will soon realize results that will cast a shadow of poverty over wheat raising.

DISCUSSION.

E. B. WILLIAMS: Does it take an intelligent man to understand the professor's statement about a cow's product being 300 pounds, and this selling at 40 cents per pound the year round?

MR. SCOBEY: Yes; it does take an intelligent man, but I am

not saying how much intelligence he must possess. The point I wanted to make, however, is this: It is poor policy to keep on raising wheat exclusively in this section till the land is exhausted and it becomes necessary to turn to the cow and other stock for immediate help. We ought to bring the cow in for work now.

DR. SIMPSON: What is the best breed for the dairy?

MR. SCOBAY: There is a difference of opinion. I prefer the Jersey, but some prefer Holsteins and other strictly dairy breeds, and others heavier breeds, because they make a good beef carcass when they become too old to milk. I do not believe in the "general purpose" cow.

MR. WATSON: What about the pasturage? Those who have been here for some years know that the bunch grass is rapidly disappearing, and that as a pasture grass for milk it is poor at best. What can we substitute for this?

MR. SCOBAY: I can't say, but in our work at the College we propose to thoroughly test this grass question. We propose to find out, if possible, if there is not some variety of grass or other forage plant that will furnish good and substantial pasturage for this section, especially through the dry season.

MR. WILLIAMS: Can we make and keep silage here?

MR. SCOBAY: Why not? We can grow corn, and certainly there is nothing in the climate that would prevent silage from keeping if properly put into the silo.

MR. WATSON: There are some men in this region that have tried it and say no to these queries. I have used cut hay and roots, and this, in a crude way, has enabled me to make the cow a profitable animal.

MR. SCOBAY: I can only think of one possible trouble with the trials already made with silage, and that is that the material was put into the silo in a too wet condition. This last remark of Mr. Watson's makes it evident to me that we may make dairying profitable here.

The noon hour having arrived, an adjournment was taken till 2 o'clock, at which time the chairman announced that the dairy question was still open for discussion.

MR. LAKE: Has any one here had any experience with the clovers?

MR. BURNS: I have sowed red clover, alone and with timothy. I sowed it on all slopes and all soils, and must pronounce it a failure. I had one fair crop, the second one, but soon after this was taken off I could go over the field where it was sown alone and take the crowns all up without breaking the roots. These seemed to be eaten off a few inches below the surface, the plants all dying finally. Neither can I pronounce timothy a success. With me it has given one good crop and then failed. These crops seem to suffer because we have no late spring rains here. I find on my place a few roots or crowns of clover doing well, but they are scattered and in very favorable localities.

A. J. WILLIAMS: Alfalfa has done fairly well with me. Alsike did well for two years, and then seemed to run out. Sanfoin I have tried, but must say it is no good here.

MR. LAKE: Has anyone tried the oat, rye or blue grasses?

MR. BURNS: I have tried the rye grasses, both American and English, but had only the most meager returns from them.

PRESIDENT LILLEY: Has anyone tried Russian clover?

E. B. WILLIAMS: One acre of rye and wild oats mixed will keep a horse or cow through the pasturing season.

MR. BURNS: I have tried most everything, and am satisfied that there is no combination of forage plants one or two acres of which will keep a cow the whole year through. It takes about five acres at best.

MR. SCOBAY: Well, even at this rate, is not the cow as profitable as wheat?

THE PATHOLOGY, CAUSES AND TREATMENT OF BONE SPAVIN.

DR. MUNN.

This is a disease of the hock joint, and is one of the more common causes of lameness in the posterior extremities.

Spavins are nearly always situated on the inner side and toward the front of the joint. A bone spavin is an exostosis or bony tumor, situated at the inner and lower portion of the joint, and is caused by an inflammation of some of the smaller bones of the joint. The articular surfaces of the bones involved become ulcerated, an exudation is thrown out, which gradually ossifies, and in the majority of cases cements two or more of the bones together. The causes of bone spavin are numerous; many horses inherit it through a faulty conformation of the joint, and also a poor quality of bone. There are also families with well formed hocks, with the bony structure apparently of good quality, which show, generation after generation, a tendency to spavins, together with other diseases of the bones.

The exciting causes are sprains and concussions of many kinds. The starting of heavy loads on slippery, irregular paving or icy roads, the hind feet slipping suddenly, producing a strain upon the ligaments which bind the bones of the hock together, and a concussion of the bones themselves; shoes with high calks, especially when the heel calks are unusually high, altering the direction of the leg and producing a concussion of the bones at every step.

The lameness caused by the formation of a spavin may at first be slight, a little hitch of the diseased leg at starting, or lameness for a few steps when first taken out of the stable, or, even before any lameness is shown, there may be noticed a tendency to rest one leg more than the other, extending the foot, the toe touching the ground, with the heel raised. As the disease progresses, the lameness, instead of disappearing after a few steps have been taken, will continue for some time until the animal has become warm by exercise, and reappearing after every rest, until finally lameness becomes continuous while the horse is in action, and considerable pain is shown while he is at rest. From lack of exercise the muscles on the affected side atrophy or shrink, and in most cases a bony swelling appears on the internal face of the affected joint, accompanied by more or less heat.

There are cases where the lameness is excessive and yet the swelling cannot be detected, and an occasional case with a bony growth of considerable size without lameness or any apparent increase of temperature during the process of its formation, the size of the tumor appearing to have but little influence over the symptoms of lameness.

In making a prognosis regarding the chances of removing the lameness in a case of spavin, there are many things to be considered.

When we remember that the hock joint is similar to the ankle joint of man and is made up of seven small bones, that the upper bones are the ones which take part in the action of the true hock joint, while the lower ones have but a limited gliding motion, we can easily understand that the nearer the spavin is located to the bones which take part in the true action of the joint, the greater will be the pain and inconvenience when the joint is in motion. If, as is often the case, the inflammation at first set up has gone so far before the cause of the lameness has been correctly diagnosed that structural changes have taken place in the bones and ligaments of the joint, and an exudation has been thrown out between the bones, and upon their surfaces, then we should attempt by the aid of counter irritants to stimulate that exudation to form a band from one diseased bone to another, which by the process of ossification binds them into one solid bone. This renders the diseased portion of the joint free from motion, and the lameness ceases. If, however, the seat of the inflammation is higher up on the joint, and the bony growth be implicated in the action of the true hock joint, it is obvious that we have an almost hopeless case to deal with. Another point for consideration is the age of the animal. It is well known that the spavin lameness of old horses is much more difficult to remove than when affecting young or middle-aged horses. The reason is that nature's reparative process progresses but feebly in the aged, but little exudation is thrown out, and the process of ulceration continues, while in the vigorous middle-aged or young horse the process of repair is vigorous, and in a large percentage of such cases, given sufficient rest and proper treatment, enough exudation will be produced, which, when ossified, will cause ankylosis, or immobility of the diseased portion of the joint, provided it occurs in a part of the joint where motion is limited and will allow the affected bones to be cemented together.

Blisters of various kinds, and the actual cautery are the counter irritants mostly used to stimulate the process of exudation and ossification. Rest is imperative, as it is very evident when we take into consideration the nature of the disease, and the process of repair we attempt to establish by our treatment, that but little can be accomplished if the animal is kept at work.

DISCUSSION.

MR. COURTRIGHT: Can a spavin be cured and the tumor removed?

DR. MUNN: No, although by proper treatment it may be much reduced.

DR. SIMPSON: What do you think of Kendall's spavin cure?

DR. MUNN: It is probably as good as any counter irritant of that class. It must be remembered that when treated for spavin horses should be given a good long rest.

DR. SIMPSON: My stock has been periodically troubled during the last three or four years with a lameness that at times is very annoying, but has not yet proved in anywise serious. It spreads from one animal to another, and may last several or only a few days.

WHEAT GROWING.

R. C. M'CROSKEY.

The Palouse country is perhaps the best wheat belt in America, the climate and soil conspiring to reward man's efforts in producing the cereals, with the most bountiful and uniform harvests. Yet there is no country with which I have been acquainted where superior cultivation and intelligent observation count for so much as here. It behooves us, therefore, to carefully study the conditions that surround us, and to so conduct our operations that we can make our lands produce the most possible in a given period, and still leave them in a condition for a repetition of the same yield for the next succeeding period.

Wild oats, cockle and pig-weed, all of which we have to contend against unremittingly, and frequently unsuccessfully, diminish materially the yield of wheat by their presence, and exhaust the fertility of the soil quite as much as does the same growth of wheat. Their presence, therefore, indicates a lower yield of grain and the exhaustion of the soil without corresponding benefit therefor. The pig-weed seems to be indigenous to our soil, and will volunteer in land that has been cultivated to wheat for many consecutive years or until the wheat producing quality of the soil has been partially exhausted. Wild oats and cockle flourish in land that has been so exhausted. The only remedy that will correct these evils, and will cause whatever strength is taken from the soil to go into the owner's pocket, is fallowing the land every other year after the first three or four crops have been taken from it. By fallowing properly, not only is the "foul stuff" eradicated, but the clods and general surface of the soil are fertilized by being exposed to the action of the sun's light and the atmosphere. These fertilized portions are subsequently turned under and other portions are turned to the surface to undergo the same process of fertilization. In addition to these advantages there is a still greater realized in virtually having two years' rainfall to produce our crop.

The amount of moisture that passes from the earth by the process of evaporation, is very slight as compared with the quantity that is taken from it, both by evaporation and the production of a crop. This can be easily demonstrated to any one's satisfaction by digging down eight or ten feet in a wheat field just after a crop has been taken off, and also digging down the same depth in a young orchard, the land of which has

been kept clean and well stirred and on which no crop was produced. In the wheat field the earth will be found to be almost entirely sapped of its moisture, while in the orchard it will be found moist to a great depth. The fine fibrous roots of the wheat penetrate, so the books tell us, sixteen feet below the surface. This appears incredible, but from personal observation I know they descend in hunt of sustenance and moisture from eight to twelve feet. Hence, to produce a large crop, the necessity of having the ground wet down deep, or of having continuous rains during the spring and early part of the summer. The latter condition is not to be relied upon. Those who have tested summer fallowing for years, consecutively, say that an average yield of fifty bushels per acre can safely be expected, while an average of twenty-five bushels, one year with another, on land that has produced four or five crops is not below the actual results. This estimate would give us in a period of ten years the same quantity of grain for each method of farming. The cost of producing a bushel of grain by the fallow method would be much less than by continuous cropping—hence the profits the greater.

My individual experience in fallowing leads me to believe there is a greater difference in the profits of the two methods than is indicated above. A few years since I rented a quarter section having some old land on it, for one-third the crop. When the haying season came, it was agreed that the crop on the old land should be cut for hay, but the best terms I could get from the tenant were that I should give him the whole crop and twenty-five cents per acre to cut and take the crop off clean. The next summer I plowed the land twice, sowed it in wheat the following fall and harvested the succeeding summer fifty-two bushels per acre. I am quite confident that not exceeding fifteen or twenty bushels for each of these years could have been obtained even with superior cultivation.

Yields from summer fallow are without exception large. I have never heard of a small one in the Palouse country. No business that I can conceive of appears to be so free from risk as farming here by this method. The farmer is thus just as sure to realize large profits as he would be to get back his principal with interest on a time deposit in a well conducted bank. It requires less stock and implements, as the grain can be sown in the fall, the remainder of the time till harvest being devoted to plowing for the next crop.

The farmer who is in debt says he cannot afford to lose every other crop. The fact is, he cannot afford to do otherwise. As small yields will inevitably impoverish any farmer in a country like ours when the cost of cultivating and harvesting is large, and the price of the grain is comparatively low.

Whether the deductions herein are correct or not, it is evident that the fallow system of farming, which has passed the domain of experiment in other countries, should receive the thoughtful consideration of every farmer. Intelligent attention is as necessary in farming as in any other business. It is related of a Frenchman who had several daughters and land enough to make a frugal support, that on the marriage of the eldest

he gave her half his farm, and by superior methods of cultivation produced as much on the remaining half as he had on the whole. On the marriage of the second daughter, he gave her half the land he had left, and on the remainder, or one-fourth of his original holdings, by careful attention and by bestowing the same amount of labor on it that he did on the whole farm he filled the same sized granaries and barns that he did before his daughters commenced marrying.

DISCUSSION.

MR. LAKE: Where can I find the statement that wheat roots feed to the depth of twelve to sixteen feet?

MR. McCROSKEY: I can't give you the authority, but I remember years ago reading it in my father's library, and I have frequently heard of similar statements from California. I have myself seen them seven feet deep in this land.

MR. LAKE: We are taught in a general way that the cereals are shallow feeders and are not these rare instances of which you speak. I have been told that much of the land in this section is underlain at no great depth with an impervious stratum of soil akin to clay. I am told that much of the dark soil on the south hillsides is not more than twelve to eighteen inches deep. If this is the case I can't see how the wheat roots can go to this depth here except in very favorable localities, so that it must be a comparatively shallow feeder still.

DR. SIMPSON: The professor has not been informed correctly. Large areas of this section have a soil rich, warm and fertile, extending from five to eighteen or more feet deep, while only a small area is underlain with a clay subsoil near the surface, and I am satisfied this clay when turned up at the right time—when it is moist—and slacked, will be as fertile as any surface soil we now have.

MR. EVANS: In digging several wells in our section of this Palouse plateau I have never yet struck what I should call an impervious stratum except occasionally when one of these clay outcroppings become thoroughly dry.

MR. SCOBEE: What does it cost to produce and market an acre of wheat?

MR. McCROSKEY: About \$9.50.

MR. SCOBAY: What is the average price obtained for the crop?

MR. McCROSKEY: Excepting the last two years it would be about fifty-two cents per bushel. Before that time it was somewhat less.

MR. COURTRIGHT: During the past six years, with the exception above made, I have paid about forty-five cents. For a period of twelve years before that thirty-five cents would be an average.

MR. SCOBAY: What is a good average crop for every year?

MR. McCROSKEY: Our best practice, I think, is conceded to be to fallow and grow one crop every two years, except on virgin land for the first five or six years. In this way we get from forty-five to sixty bushels per acre.

MR. SCOBAY: That would make an average of twenty-five bushels or more for each year. This would leave in the neighborhood of \$2.50 to \$3 per acre profit. I think I should prefer the cow at this rate, even if butter sold for twenty cents per pound. How much do the best farmers sow per acre?

MR. McCROSKEY: From one bushel to one and a half bushels. I deem one bushel enough, and after some trials find this amount to give best returns.

MR. CHASE: For the last few years I have sowed one bushel. Before this I used from five pecks to one and a half bushels. But when we have dry hot winds more damage is done the thick than the thin seeded fields, and in the average season I think the yield somewhat ahead when one bushel is used.

A. J. WILLIAMS: It must be remembered that we have only been raising wheat in this section a few years, and during those few years we have had good prices; before this we only had a small area in wheat and prices ranged accordingly.

MR. BURNS: Though our main crop is wheat, and we are not getting poor raising it, I think we should do more or less grazing. Both together are surely better than either one alone. But if we should all go into dairying we should not only get less than forty cents per pound for butter, but we should be

obliged to give it away. In fact I have seen the time, and that not longer ago than last summer, when we had to pack it at home, as the markets were overstocked. And in wheat raising I think we must summer fallow if we would maintain our present yield. For the first few years on virgin land we can raise a crop every year, but this should not be long continued.

MR. SCOBAY: This market question for the dairy product is a myth. It is true we may not have a local market, that is quite probable; but if we once get to manufacturing this product in bulk the outside market will soon be ours. Buyers cannot afford to come here for a crock or washtub full when they want a carload. I should like to ask from what seedings you get the best results, spring or fall, and from drill or broadcast?

MR. CHASE: I have tried both and can see no difference. I should use the drill in the fall and broadcast in spring.

MR. BURNS: Three years ago I sowed fifty acres; half was drilled, the other half was broadcast. There was no perceptible difference in the yield, though it was all sown at the same time and other similar conditions save the manner of sowing.

E. B. WILLIAMS: We are troubled here with considerable smut, and I would like to know what causes it.

PRESIDENT LILLEY: How do you treat your seed?

MR. WILLIAMS: We vitriol it, but some years there seems to be no difference between that treated and the untreated seed.

MR. EVANS: I vitriol my seed, and have no trouble with smut.

MR. CHASE: If vitrioled thoroughly, and soil is in good condition, there will be no loss from smut. I use one pound to eight bushels of grain, and my grain has been practically free from smut for years.

MR. CLARK: Some years since, we sowed several acres of wheat by lands as fast as plowed. It all did well save one corner, which was on a northwest hillside. This was badly affected with smut, and I charged it to a thunder storm which passed over this portion in full fury.

—: I have noticed that the greater part of heads partially affected have the southwest side injured.

PRESIDENT LILLEY: There is a germ on the kernel, and this must be killed before the seed is sown. It would seem that if vitrioling is well done there would be no chance for this trouble. There are several fungicides used. The one that seems to give the best results in Kansas, Nebraska and the two Dakotas is immersion of the seed for fifteen minutes in water at 134 degrees Fahrenheit. Care must be taken to keep the water at that temperature during the process. The seed should be placed in a basket or a frame lined with wire gauze, and when dipped into the hot water the temperature will fall. This must be overcome at once by adding hot water until the original temperature is reached. The temperature must not fall below 130 degrees, and never be above 135 degrees. If the seed is freed from adhering spores it will produce a clean crop. The grain may be treated several days or weeks by the hot water process before seed time, or it may be sowed directly after the treatment and before completely dried.

MR. BURNS: If the seed is well disinfected there will be no smut. The common way of dipping a sack full into a barrel, and letting it soak, is an uncertain way of treating it. The seed should be put into a vat or trough and thoroughly mixed with vitriol.

MR. LAKE: It seems to me the question of wheat smut is not settled as well as it ought to be for an institute the size of this. It should be known that the smuts are plants—parasitic in nature—and have parts that correspond to the seeds of other plants. The dust from a “toadstool” or a “puff ball” is the seed of those plants, and so the dust from a head of smutted wheat is the seed of the smut plant. This dust, or these seeds, or spores, as they are called, settle upon the whole grain. When these latter are sown the smut spores are sown with them, germinate with them, and as the root (?) body of the smut plant grows it enters the young wheat sprout and grows with it, taking from the wheat plant what material it needs for its development—the same as a louse may live upon an animal, for instance—and when the wheat plant makes ready to ripen its grain the smut does likewise, taking for its own use the

milk of the wheat kernel and transforming it into smut spores for another crop of this plant. When the smut plant which is living in and upon a particular wheat plant is strong, it may consume the milk of a whole head for its own use, while if it is weak only a portion may be consumed, thus making whole, half, or less smutted heads.

A WORD ABOUT WINDBREAKS.

PROFESSOR LAKE.

In all ages the influence of forest areas and shelter belts on climate has been fully recognized and in many instances has become a theme for discussion by eminent thinkers, philosophers and economists. At no period in the past, however, has the real significance of the climatic influence of forest areas been so generally discussed and highly esteemed as to-day. Never before has the mass of people, especially the soil-tillers, been so enlightened on this subject as now, and still we, the people of the most progressive nation on earth, are groping along in forestal darkness and ignorance with regard to a subject of most vital interest to our welfare in various directions. But, directing our attention to one phase of this subject which more especially interests us locally, we find not only an indifference, but an apparent antipathy to its consideration. This treeless expanse of heavy rolling land is looked upon as the Eutopia of the agriculturist, but it is with an eye single to cereal growing that it is so seen. As history attests, wheat growing followed for a long period of years will not only impoverish the most fertile soils but it will impoverish the people who follow it, both mentally and financially. Not that wheat growing is not necessary or desirous, but to make it the exclusive crop is unwise and prodigal in the extreme.

Every crop requires for its best development and profitable culture certain mineral elements, which are taken from the soil. Some plants require more of a certain element, as potash, for example, than others; while these second ones will require more of certain other elements than the former. This makes it incumbent upon us to vary our crops if we would maintain our soil fertility. No crop affords a better source of revenue than the fruit-tree crop, when properly managed, and it is a crop that will flourish for years and years on our peculiar soil without materially lessening its fertility, for, be it understood trees are deep feeders, while the cereals are shallow or surface feeders; so that while the tree's roots may ramify through tons of earth, the roots of the cereals will only course and recourse through the few inches annually or biennially turned by the plow — all plant food lying below that depth being practically be-

yond our reach, and of no avail in the manufacture of plant products of this class.

But while the fruit-tree crop may be the means of bringing this otherwise inert material into activity, it may not be a profitable crop; for if the fruit product from this crop should, for any reason, be restricted, the income from the fruit crop might be a negative quantity; however, such results are, in all probability, not likely to fall to the lot of the careful orchardist in the northwest. In this particular section, where orcharding is yet in its infancy, and where the natural tree growth is practically nothing, there are some matters to be considered that do not occur in other sections, and chief among these is the subject of windbreaks.

At the recent institute held at Colton, it was learned that while all the hardy orchard trees may and have done well in several instances for the past ten and twelve years, there being no cases recorded of the winter-killing of such trees, they do not produce as much fruit on the south-south-west side as on other parts of the trees—in fact, where the trees are exposed to the “chinooks,” they are not so fully developed on the windward side as on the leeward side.

These facts coupled with the general conclusions that our prominent horticulturists and foresters have long since reached, in regard to the ameliorating influences of timber belts and screens, lead me to urge upon all who would plant fruit trees the desirability of planting windbreaks. Since it is somewhat impracticable to have any large bodies of timber in this section it devolves upon us to plant many small belts or screens. To enumerate briefly some of the advantages of windbreaks I can do no better than give a summary of some investigations recently carried on by Professor L. H. Bailey, in which he states the benefit of windbreaks to be: protection from cold; lessening of evaporation from soil and plants; lessening of windfalls; lessening of liability to mechanical injury of trees; retention of snow and leaves; facilitating of labor; protection of blossoms from severe winds; enabling trees to grow more erect; lessening of injury from the drying up of small fruits; hastening of maturity of fruits in some cases; encouragement of birds; ornamentation.

There are some drawbacks also if we consider the experience of fruit growers as conclusive. Windbreaks are said to harbor insects; fungous foes; to encroach upon the orchard planting, and to keep out warm winds.

These are minor objections, however, and so far as this great inland territory is concerned, have no weight as against the benefits.

The position of windbreaks will depend much upon the local position of the orchard. For many reasons the aspect to be selected should be a northern one. This would imply a screen on the south and west sides. Where an orchard is to the eastward of a high hill a screen on the south would be all-sufficient.

Perhaps our needs here would best be met by planting a mixed belt, and for this purpose our native trees could be used to advantage. Our native firs and pines mingled with maples, cottonwoods and more or less nut trees would undoubtedly make excellent windbreaks. If belts of

these trees, varying in width from forty to sixty or more feet, with the deciduous trees on the windward side and the firs and pines not closer together than eight or ten feet, planted at the same time the orchard is set out and at least two rods, and better four rods away, results from orcharding with the hardier fruits would undoubtedly be much more favorable in this particular section

Windbreaks should not be dense. They are simply to break or check the wind and not to stop it.

DISCUSSION.

MR. LOVE: When I came here some years ago people told me not to waste any time, labor and money in growing fruit. After I had heeded this very poor advice four years I planted out some apples. This was five years ago. A large part of them killed off. But not being satisfied with the experience, I tried again. This time I put out one-year old trees instead of three-year old trees, and here (exhibiting a good sized, fair colored Ben Davis) is a fair sample of the fruit picked from these trees this past autumn. Does that not speak for itself? But I am not certain that I have been wise in planting my orchard on a north slope, though that is the general advice given. I find that my trees grow vigorously, produce a great amount of foliage, and give a good crop of fruit, but much of it is not well colored; being on the north side, it is too much shaded. Would it not be better to have these trees where they can get more direct sun?

MR. LAKE: At the recent meeting at Colton, Mr. Barkhuff stated that those trees in his orchard exposed to the winds did not develop on the windward side, and consequently the fruit was much inferior as well as less in quantity on these portions. If the slope is not too abrupt it would not seem that our trees could get much more sun on an easy south slope than on a similar north one, with our long, bright autumn days; for in either case the north side of the tree would be shaded, and especially so if the tops are dense. No, I think Mr. Love has not been unwise in selecting a north slope. If his trees grow over-vigorously, he should prune as vigorously, and open the heads. The advice to plant on a north slope is generally given because trees in this location are less liable to winter-kill, blight, sour-

sap, etc. If we were to plant windbreaks generously I doubt not it would be advisable to plant many of our hardier and late varieties on a southerly exposure. But it will be years before the average planter will realize the full importance of windbreaks, not only to his orchard, but his stock, and indirectly, himself as well. In the meantime, I think it wise to select northern slopes, not abrupt ones, but gentle ones, so that trees may be protected from the chinook blasts and too much of the warm rays of the sun in early spring.

MR. LOVE: I find it essential to healthy trees that they be headed low, not more than two feet, and trees should be well cultivated. If one can go into an orchard and by pushing aside a few inches of the soil find it moist below, the orchard is in the best of condition.

MR. LAKE: Another point in orchard care that should be looked to in this Northwest is the matter of thinning fruit. Our trees are prone to over-produce, resulting in much damage to the physical make-up of the tree, as well as yielding a crop of fruit more or less inferior in size, flavor and color. This thinning should be done early in the season, and as soon as the orchard begins to bear heavily. Look to this matter of pruning and thinning before the trees get old and partly broken down.

HANDLING AND MARKETING GRAIN.

J. O. COURTRIGHT.

We will attempt to notice briefly several questions pertaining to the marketing of grain, but more particularly wheat.

The first thing is to see that the grain is properly harvested and threshed, and particularly to see that the wheat is not cracked in threshing. There is nothing more destructive than this, as the broken grain can only be used for feed and causes a direct loss.

We will next notice the question of sacking grain. It is generally conceded that it is cheaper and more convenient to sack the grain at the machine as it is threshed, and this is doubtless true as long as we follow the present ruinous practice of selling and shipping our wheat without cleaning. But when the practice becomes universal of cleaning our

wheat, either at the shipping point or terminal elevators, it will be far better and cheaper to have granaries on the farm to receive the wheat as threshed, and deliver it loose to the warehouses or elevators.

By comparing the cost you will find that granaries can be constructed of common lumber, that will last several years, to cost less than the sacks would cost for a single crop; and they could be so constructed that an elevator could be attached to the thresher and the grain carried directly into the granary and drawn out into wagon boxes, without any of the hard labor of lifting and handling sacked grain. It is sometimes argued that our roads are so rough that the grain would spill out, but extra sideboards on the wagon boxes would prevent that.

Recent experiments in shipping wheat to Europe has proved that wheat can be shipped in bulk, and when the Nicaragua canal is completed we may expect to see the larger portion of the wheat exported from the United States shipped from the Pacific coast ports.

The question of cleaning our wheat for market is a very important one in several respects. It is often urged, and is at present in a great measure true, that our prices are based on what is called Walla Walla wheat, which means just as it is threshed, without recleaning, and that if we *should* clean it we would not receive any better price and would lose just the amount cleaned out. That would only apply at all to Portland and Puget Sound markets; and there is no good reason why, with a careful selection of the best varieties of seed wheat and the practice of cleaning being universal, that our wheat should not grade with Willamette Valley wheat in that market, and in our local and Eastern markets it would make a very material difference. In one instance coming under our notice, by docking from one-half pound to one pound per bushel, the grade was raised from seven to eight cents per bushel.

We believe the best place for cleaning grain to be shipped is at the shipping point, where the grain is being delivered to the elevators, thereby saving quite an item of freight and insuring a more uniform grade, and thus avoiding the pretext for rejecting.

And right here we would urge the necessity for state weighers and inspectors. Our experience has taught us that exporters left to do their own inspecting manage to enlarge their profits at will at the expense of the farmers by grading too low.

With state inspection and weighing a farmer could feel perfectly safe in consigning his wheat to a responsible commission merchant for sale.

The plan of coöperation in storing and selling grain is of great value to the farmers, inasmuch as it gives them the advantage of knowing just what their grain is worth on the market, and enables them to obtain full market value besides the saving in storing and handling charges. We hear and read a great deal about *gambling in grain*, and a bill has lately been introduced in congress to correct the abuses of board of trade dealings, and we hope such laws may be passed that will effectually prevent speculators selling large quantities of grain which they do not own nor expect to deliver, thereby depressing prices to the farmers until they get the larger portion of crops in their possession and then raising the prices

to consumers, thus robbing the farmer on the one hand and largely the poor laborer on the other.

The question which probably perplexes the farmer more than anything else is the *time to sell*.

Even before the crop is planted the intelligent farmer begins to look ahead to see, if possible, what the prospects are for prices for the coming crop; whether the outlook justifies a larger or smaller area of the different varieties of grain. Here we see the need of a bureau of information separate and distinct from that given by the boards of trade and speculators.

This the agricultural department of our government is intended to accomplish, but at present the knowledge to be obtained from there is not sufficiently published. Bulletins should be published monthly at least in all the leading newspapers, that both the farmer and consumer may know all the facts appertaining to crops and probable prices, at different periods during the year. Until we are able to obtain such information we will have to depend on such knowledge as we can obtain and our own best judgment.

One thing that is highly advisable as a rule is not to borrow money at a high rate of interest to hold grain. In certain cases it might pay to hold, as when prices are reduced by too much grain being offered, but in a great many cases it is akin to gambling.

STRANGLES; OR, COLT DISTEMPER.

DR. MUNN.

Strangles, or colt distemper, is a disease which affects nearly all young horses, and while not generally considered of a very serious nature, for but a small percentage of cases are fatal, yet when we take into consideration the fact that but few horses arrive at maturity without an attack of more or less severity, and also that not a few cases are left with some chronic disease, the result of ignorance or carelessness in the treatment and care of the animal while affected, it should be of advantage to arrive at as clear an understanding as possible of its nature, symptoms, and a rational method of treatment.

It is defined as being a febrile disease commonly affecting young horses, and in most cases characterized by one or more abscesses situated between the branches of the lower jaw, which if they reach maturity discharge pus.

Under certain conditions it appears contagious, while under others it shows no tendency to spread. It seldom attacks an animal but once, although there are exceptions to this rule. The name, strangles, is derived from the symptoms of choking and strangulation which are common in many cases.

This disease occurs in two forms: Simple, or regular, strangles; and complicated, or irregular, strangles. In the simple, or regular, form it is not a very serious disease. The animal is dull, has a languid, tired appearance, with symptoms similar to catarrh, saliva issues from the mouth, and more or less discharge from the nostrils; at times the head is carried in a position which would indicate soreness of the throat or jaws, is not inclined to feed, and has some difficulty in deglutition, combined with a cough more or less severe; the pulse and respiration are somewhat affected, and a swelling shows itself in the submaxillary space, which often increases to such an extent that the breathing is interfered with, and in some cases death results from suffocation.

The disease in its simple form generally runs its course in from six to twelve days, and the animal regains his health and strength in from two to three weeks.

By the term irregular or complicated strangles is meant that form of the disease in which the ordinary symptoms and features are departed from. This form of strangles most frequently attacks horses that are constitutionally weak and those that are poorly cared for and in an unthrifty, debilitated condition.

There is an increase in the temperature, the pulse more frequent, swellings and inflammation are absent from the submaxillary space and found in connection with the parotid gland, below the ear, the lymph glands of the neck, in front of the shoulder joint, in the groin, or in connection with the gland structures of the internal organs. Although this form of strangles is generally irregular and complicated from the start, it is sometimes observed in cases that begin as simple strangles, the swellings in the submaxillary space makes its appearance but does not progress to a healthy termination, the formation of pus is tardy, or the inflammatory product appears to be absorbed, and the entire system is disturbed. Tumors may form in the thoracic or abdominal cavity, and a case in which this occurs generally terminates fatally.

In treating horses affected with strangles, it becomes quite evident that those which are kept in dark, damp, ill-ventilated stables, invariably suffer more from the severity of the disease, are affected for a longer period, and do not make as good a recovery as do those more favorably located, with the advantages of a pure, dry atmosphere, with good light. We should be particular, then, to obtain, if possible, these very valuable requisites to our treatment. As this disease is more common during the spring and fall, our patient should be protected by proper clothing from the sudden changes in the atmosphere. Few cases of simple strangles require much medical treatment. There will be more or less fever, and with it thirst. Clean, fresh water should be kept within reach of the patient, and in it we may dissolve mild febrifuges, as nitrate of potash, one-half ounce to a pail of water, or solution of the acetate of ammonia, four or five ounces, or a like amount of sulphate of magnesia. Give food that will be nourishing and easily digested without causing irritation to the digestive organs.

Pay particular attention to the swelling in the submaxillary space.

Hot fomentations and poultices hasten the formation of pus. The parts should be kept clean, and, if the tumor appears to be slow in pointing, a mild blister will often stimulate the local action and develop the abscess, which when mature will soften, rupture the skin and discharge itself, or, in some cases, may be opened. In cases of irregular strangles, the same general treatment should be adopted.

Too much stress cannot be laid upon the fact that proper diet and sanitary conditions are of as much importance as the medical treatment. When green food can be obtained and given fresh in moderate quantities, it is preferable to any other. When not obtainable, scalded oats and bran, with two or three ounces of raw linseed oil or molasses, may be given two or three times a day, along with good hay in small quantities.

If local inflammations or swellings indicate pus formations, treat as directed in the simple form, and give a dependent opening when abscess matures.

In cases where loss of appetite is persistent and the animal refuses all ordinary food, try liquid food, as milk and good beef tea; and, although not to be recommended except in desperate cases, it may become necessary to forcibly feed the animal for a few days on such food as raw eggs whipped up in milk, together with wine or ale.

In those cases, which happily are comparatively few, the swelling in the submaxillary space becomes of such size before maturity, or the inflammation affects the larynx and upper air passages to such an extent, that the function of respiration is obstructed and there appears great danger from suffocation, it may become necessary to perform tracheotomy—that is, to place a tube in the windpipe below the obstruction, thus allowing our patient to obtain the oxygen needed to sustain life.

During recovery good food and care should be continued, and a little exercise should be given as the animal gains in strength; but do not expose to cold or put to work until health and strength have entirely returned.

DISCUSSION.

MR. COURTRIGHT: Will distemper or strangles run into nasal gleet or glanders.

DR. MUNN: It may render the animal more susceptible to gleet, but no disease will run into glanders.

MR. EVANS: Is this disease contagious?

DR. MUNN: Yes.

MR. SCOBAY: How do you perform tracheotomy?

DR. MUNN: Make an incision in the under side of the wind pipe, about six or eight inches below the swelling, and insert a tube.

A MEMBER: Does the wound need to be sewed up?

Dr. MUNN: No, it will heal up if given good care.

Mr. SCOBAY: In what cases would you lance the abscess?

Dr. MUNN: In cases where the abscess appeared to be soft and fluctuating, yet the skin too thick to allow the pus to escape and the liability to the formation of pipes or sinuses.

Mr. SCOBAY: How would you treat the abscess after it is lanced or has ruptured itself?

Dr. MUNN: Keep clean and inject with solution of carbolic acid of blue vitriol?

Mr. SCOBAY: What is liable to result from strangles?

Dr. MUNN: Roaring or whistling, and in some cases blood poisoning.

ATTENDANCE.

The following persons were in attendance:

John H. Bland,	Garfield.	J. T. Allison,	Garfield.
George Wykoff,	Garfield.	Jas. L. Dutton,	Garfield.
T. F. Mullin,	Garfield.	S. C. Rapet,	Garfield.
Mrs. L. J. Halley,	Garfield.	B. L. Simpson,	Garfield.
A. T. Davis,	Garfield.	Fred. W. Kock,	Garfield.
Frank Ayatt,	Garfield.	N. C. Bicknell,	Garfield.
Mrs. L. A. Manning,	Garfield.	H. H. Shally,	Garfield.
C. E. Highey,	Garfield.	R. I. Evans,	Colfax.
John M. Hendry,	Garfield.	L. L. Potter,	Garfield.
Isabel Irwin,	Garfield.	Ora Mauring,	Garfield.
A. J. Irwin,	Garfield.	Samuel Irwin,	Garfield.
J. H. Longwill,	Oakesdale.	W. M. Sells,	Garfield.
E. W. Williams,	Garfield.	Alvira Mauring,	Garfield.
A. W. Lemon,	Garfield.	Alvin Mauring,	Garfield.
G. E. Selts,	Garfield.	Frank Larkin,	Garfield.
Delina Morris,	Garfield.	J. M. Chasteen,	Garfield.
Mrs. Wm. Duling,	Garfield.	Eli Mason,	Garfield.
P. H. McIntosh,	Garfield.	L. L. Bondeli,	Garfield.
Callie Beach,	Garfield.	Perry Larkin,	Garfield.
Ocille Mitchell,	Garfield.	S. B. Shoemaker,	Garfield.
S. Sage,	Garfield.	Mrs. Cawfield,	Garfield.
E. B. Williams,	Garfield.	Mrs. G. W. Turner,	Garfield.
R. B. Thompson,	Garfield.	S. T. Laird,	Garfield.
A. P. Hall,	Garfield.	Mrs. P. W. Lawrence,	Garfield.
James Barber,	Garfield.	Mrs. E. E. Steele,	Garfield.
P. H. Burk,	Garfield.	Mrs. William Laird,	Garfield.
Henry Hill,	Garfield.	Maud Williams,	Garfield.
Gus. Becker,	Garfield.	Miss Duling,	Garfield.
William Hendry,	Garfield.	Miss Baylor,	Garfield.
John Beach,	Garfield.	Dr. Samuel Simpson,	Garfield.
J. E. Roberts,	Garfield.	J. H. Watson,	Garfield.
W. W. Reorin,	Garfield.	E. B. Williams,	Garfield.
L. P. Rounds,	Garfield.	J. N. Bicknell,	Garfield.
W. H. Gwinn,	Garfield.	William Laird,	Garfield.
A. J. Madden,	Garfield.	Jesse Gilliam,	Garfield.
C. T. Ryckman,	Garfield.	A. S. Beach,	Garfield.
S. P. Syron,	Garfield.	S. J. Taut,	Garfield.
D. Black,	Garfield.	Adam Black,	Garfield.
J. G. White,	Garfield.	Geo. Mauring,	Garfield.
L. S. Trowbridge,	Garfield.	Chas. Finch,	Garfield.
D. D. Vernon,	Garfield.	F. L. Gwinn,	Garfield.

L. C. Love,	Garfield.	William Gore,	Garfield.
M. F. Cochran,	Garfield.	L. W. Fallis,	Garfield.
N. K. Gartin,	Garfield.	Chas. McMillan,	Garfield.
C. A. Boyd,	Garfield.	Chas. Syron,	Garfield.
Jacob Dieus,	Garfield.	Saut. Mauring,	Garfield.
Mrs. J. R. Bennett,	Garfield.	Lee McCool,	Garfield.
Z. Cox,	Garfield.	G. B. Lish,	Garfield.
Hon. R. C. McCroskey,	Garfield.	Grant Discus,	Fairfield.
John Williams,	Garfield.	J. E. Brown,	Garfield.
A. J. Chase,	Garfield.	William Syron,	Garfield.
A. J. Williams,	Garfield.	W. C. Clark,	Garfield.
E. W. Jones,	Garfield.	William Westacott,	Garfield.
M. Byrne,	Garfield.	W. S. Sanders,	Garfield.
Fred. Timm,	Garfield.	Fred. Bicknell,	Garfield.
W. A. Disney,	Garfield.	William Simpson,	Garfield.
A. R. Smith,	Garfield.	Earnest Lloyd,	Garfield.
T. H. McCown,	Garfield.	Luther Burns,	Garfield.
L. B. Subking,	Garfield.	Rob't McGowen,	Garfield.
E. M. Coleman,	Garfield.	J. S. Randolph,	Garfield.
J. E. Bridwell,	Garfield.	W. V. Crabtree,	Garfield.
Frank Van Horn,	Garfield.	Bryan Westacott,	Garfield.
F. McLosh,	Garfield.	J. O. Courtright,	Garfield.
A. L. Webster,	Garfield.	A. D. Lloyd,	Garfield.
J. R. Bennett,	Garfield.	Col. Duling,	Garfield.
Isaac Fields,	Garfield.	A. Overby,	Garfield.
F. G. Mitchell,	Garfield.	Frank Madden,	Garfield.
M. Baumgartner,	Garfield.	G. F. Stivers,	Garfield.
C. A. Peairs,	Garfield.		

For announcements of the courses of instruction, bulletins of the Experiment Station and farmers' institutes, address the president of the College.

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EXPERIMENT STATION,

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BULLETIN 4.

DEPARTMENT OF AGRICULTURE.

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EDWARD R. LAKE, M. SC.,
Horticulturist and Botanist.

GEORGE G. HITCHCOCK, A. B.,
Chemist.

CHARLES E. MUNN, V. S.,
Veterinarian.

ASSISTANTS.

EDWARD J. CHEATHAM,
Foreman of the Farm.

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ELMER SPARR,
Teamsters.

E. QUIMBY MERRIMAN,
Mailing Clerk.

WIREWORMS.

Reports have recently been received at this Station that a worm, supposed to be the wireworm, was at work in the wheat fields in the western part of Garfield county, in this state, with requests that the matter should be investigated and a report made for the benefit of the farmers of that section, or wherever the pest should make its appearance.

A messenger was accordingly dispatched under the direction of this Station to the affected district with instructions to make a collection of the worms.

Through the efforts of the farmers of that section, coöperating with the staff of this Station, we have been put into possession of a large number of specimens of the pest.

An examination of the worms received shows them to be wireworms, of which about ninety per cent. are of the species known as *Melanotus communis*, and which has sometimes been called the "corn wireworm," although there exists no reason why it should be so termed, as it works upon wheat and other plant seeds and roots as well as upon corn. The other ten per cent. of the specimens received belong to the species known as *Agriotes mancus*, or the wheat wireworm.

The wireworm is a well known, and in many localities a much dreaded pest, infesting field crops generally. Where they abound in large numbers they are invariably destructive to crops.

The wireworm is a slender worm and when full grown reaches a length of from one inch to an inch and one-fourth. The body is cylindrical in form, with the ventral or under part considerably flattened. The body is divided into segments of nearly equal length, except the first three immediately back of the cephalic or head segment. The first of these is subquadrate, or nearly of equal width and length. The two following segments are each about one-half the length of the first segment. The caudal segment is generally much more flattened than the other segments of the body.

The body has a smooth and very hard surface, by reason of which the common name "wire worm" has been suggested. It is supplied with six short, stout legs, three on each side, and attached to the first three segments of the body at the rear of the cephalic segment.

This general description enables us to detect the worm wherever it may be found. The various species may be determined by certain minor characteristics, subordinate to its distinguishing generic features.

The following is a dorsal view of a wire worm somewhat enlarged for convenience in production:



FIG. 1. Dorsal view of wireworm, enlarged.

The distinguishing features of the various species are to be found generally in the color, the formation of the various parts of the cephalic segment and the varying peculiarity of the caudal segment.

We will give a description of the two kinds received at this station from Garfield county.

The species of wireworm known as *Melanotus communis*, to which the larger portion of those collected and forwarded to this Station belong, has the general characteristics of the genus, of being sub-cylindrical in form, segmented, smooth, hard and wire-like, and body very sparsely haired. The color, however, is a light brown, with the head and adjacent segments somewhat darker and the ventral portion somewhat lighter. The caudal segment probably furnishes the most distinguishing feature of this species. This segment is much flattened and concaved, and the sides are each marked by two depressions or notches, giving it a fluted or wave-like appearance. This caudal segment ends in a short and somewhat blunt tubercle. The dorsal or upper portion of the caudal segment is marked by five longitudinal impressions, four of them being nearly parallel upon the cephalic portion of the segment, while the fifth runs along the middle of the segment, beginning just below the bottom line of the other four and continuing to the caudal extremity of the segment. The ventral or under portion of this segment is wrinkled. Figure 2 is a dorsal view of the caudal segment of this species.

The species of wireworm known as the *Agriotes mancus*, or wheat wireworm, and of which a few were found among the specimens

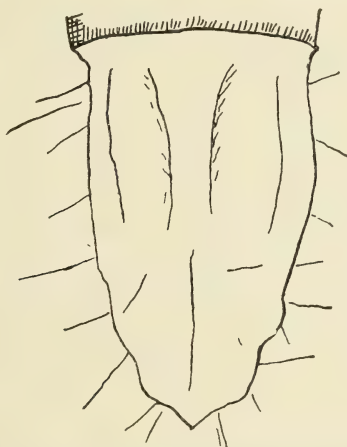


FIG. 2. Dorsal view of caudal segment of *Melanotus communis*, enlarged.

sent us from Garfield county, has the general characteristics of the genus, such as the cylindrical, segmental body, flattened on the ventral portion, smooth, wiry and sparsely haired. The color of this species, however, is a very light yellow, while its head and caudal segments differ quite considerably from the other species. The caudal segment, instead of possessing fluted sides, tapers regularly and smoothly to a moderately sharp point, which is of a brownish color.

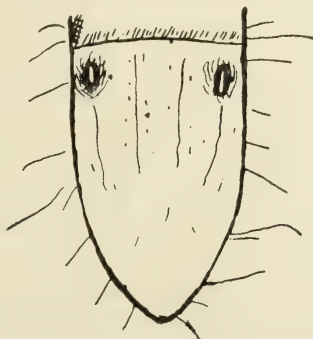


FIG. 3. Dorsal view of caudal segment of the *Agriotes mancus*, enlarged.

On each side of this segment, near its sutural conjunction with the preceding segment, is a very marked oblong depression, distin-

guished by a darker color than the surrounding surface of the segment. From the lower end of each of these depressions is a short longitudinal line, and two similar lines are located inward, equidistant from each of these oblong depressions. Figure 3 is an enlarged view of the caudal segment of this species of the wireworm.

ORIGIN OF THE WIREWORM.

The wireworm is the larva, or hatch, of the egg of a beetle, commonly known as the click-beetle. This is a small, brown or black beetle, and is sometimes recognized from the fact that when placed in any unnatural position it regains its feet by throwing itself into the air by an action of the body which produces a short, sharp, clicking sound. There are, of course, many species of click-beetles, the number being coëxtensive with the different varieties of wireworms.

The beetle, generally speaking, is a small insect, varying in size from an eighth to probably five-eighths of an inch in length.

These beetles are supposed to deposit their eggs at the spring time, in the earth, where they hatch, producing the wireworm. When the worm has lived its allotted time, variously estimated to be from two to five years, it passes into a state of pupation; it commences its transformation from life as a worm to life as a matured beetle. In the earth it makes a small oval cell in which it immures itself, and in a few weeks it molts, and out of its wiry skin comes a soft white pupa, which in general form resembles the mature beetle.

This process is said to begin about the first of July, and that it requires about three weeks to effect the transformation. This information is furnished upon observations made in the eastern sections of our country. There is no reason to suppose that it might be different in Washington, but observations will be carefully made that our knowledge of the matter may be perfect. The pupa soon after takes on the form of the matured beetle, excepting that at first it is nearly white and quite tender, but it soon matures. It remains in the ground until the ensuing spring, when it emerges again to lay its eggs, and thus keep up the process of reproduction.

DESTRUCTION OF THE LARVÆ AND THE BEETLE.

For much of the information now possessed concerning the life and habits of this pest, the agriculturists of this country are in-

debted to the careful researches and valuable experiments conducted by Prof. J. H. Comstock, the entomologist of Cornell University, New York.

Prof. Comstock has conducted some especially interesting experiments with reference to the destruction of the larvæ, the pupæ and the mature beetles, and has arrived at conclusions that are noteworthy as being of essential value to the farmers wherever the wireworm has taken up its habitation. His experimentation extended over a period of about three years, employing three methods of action—first, protection of the seed; second, destruction of the larvæ, and third, the destruction of the pupæ and matured beetles.

Under the first head, the protection of the seed, experimentation was made by coating the seed with Paris green and flour, and by a coating of tar; also by soaking the seed in solutions of salt, copperas, chloride of lime and copperas, kerosene oil, turpentine and strychnine. Without going into the specific results of these experiments, which, while interesting, would extend this bulletin unnecessarily, we will say that none of the processes employed were successful in preventing the worms from attacking the seed.

Under the second head, the destruction of larvæ, or worms, experimentation was made by the process of starvation, but it was found that the worms would remain healthy and active for eighteen months (and how much longer it is not known, as the experiment was not continued beyond that period) in soil where there was no growing vegetation. Destruction was also attempted by the use of insecticides, both by substances that act merely as insecticides and substances that act as fertilizers and incidently as insecticides, but both were without avail.

Then the destruction of the pupæ and the mature beetles was attempted, first by fall plowing the ground, and second by trapping. The former method was intended especially for the pupæ, and the latter for the click-beetles. The experiment of ridding the fields of the pupæ and the beetles by these methods has proven in a large degree successful.

It has been ascertained that after the worm commences the process of pupation he loses his power of action as a worm, and the slightest disturbance or interference will operate to destroy him. This is likewise true of the pupa and of the young beetle. Assuming that the worm commences to pupate on July 1st, it is reasonably sure that any reasonable disturbance of the earth in

which the cell is located up to perhaps the first of October will destroy a large proportion of the pupæ and young beetles. It is recommended that the ground be not only plowed but that it be frequently stirred and also rolled, as the worms do not thrive so well in soil that is compact.

The process of trapping the mature beetles has also proven very successful, the best baits used being wads of green clover and pieces of cornmeal dough sweetened with sugar. It was afterward ascertained that by dipping these baits into Paris green water and placing them under boards in various parts of the field that the beetles were readily poisoned, thus saving the labor of collecting them from the traps.

It is therefore suggested that these methods of prevention and destruction, so carefully worked out by Prof. Comstock, be employed by the farmers in Washington, as they will undoubtedly prove the most effectual treatment that can be used, unless it be found that the habits and operations of this pest are much different here than in other parts of the country. The latter is hardly possible.

In the meantime we request that farmers forward to this Station specimens of beetles and worms, that they may be more fully studied with reference to their life and habits, and also transmit the result of any observations that may have been made regarding them.

All express charges or postage, or other actual expense incurred in forwarding specimens, will be paid by the Station.

J. O'B. SCOBEE, *Agriculturist.*

STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 5.

REPORT OF FARMERS' INSTITUTE HELD AT POMEROY,
WASHINGTON.

MAY, 1892.

OLYMPIA, WASH.:

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For Catalogues of the College, information in relation to the courses of instruction, and Bulletins of the Station, address President Lilley.

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ELMER SPARR,
Teamsters.

E. QUIMBY MERRIMAN,
Mailing Clerk.

REPORT OF FARMERS' INSTITUTE,

HELD AT POMEROY, WASH., MAY 15, 1892.

The third institute of the present series was held at Pomerooy, Garfield county, Saturday, May 15. President Lilley called the meeting together, and stated the object of the meeting to be that of discussing the various subjects of interest to the farmer and fruit grower, and also to explain the objects and workings of the College and bring the College faculty in close touch and sympathy with the industrial interest and people of the entire state.

Upon motion, Rev. L. J. Whitcomb was elected chairman, and G. F. Jackson, secretary.

The orchestra then rendered a choice selection, after which President Lilley spoke as follows :

STATE AID FOR THE AGRICULTURAL COLLEGE.

The legislature of the state has at all times shown a disposition to meet the requirements of the federal government in locating its Agricultural College.

It has passed laws for the erection and equipment of suitable buildings in which to conduct the work of the College.

It has provided for obtaining land on which to erect buildings and conduct the experimental work of the Government Agricultural Experiment Station. These questions received the attention of the first legislature of your state.

This session passed a law, approved March 28, 1890, providing for the appointment of a "commission of technical instruction," consisting of three members; it also provided for the organization

of the College. By the terms of this act the commission was required to select a location for the College previous to the first day of June, 1890.

Owing to the inability of the commission to agree on a suitable location, this law became nugatory. Had this law gone into effect, and had the College been promptly and properly organized during the summer of 1890, the state would have received, under the provisions of the "Hatch" and "Morrill" acts, forty-six thousand dollars from the general government in addition to what it is now receiving from it.

Thus it became necessary to legislate again on this subject. This was done by the second and last session of the legislature, which promptly passed an act, approved March 9, 1891, providing for the location, support and improvement of the State Agricultural College.

By the terms of this act the state accepted all the conditions and endowments of the federal government, as required by congress.

The appropriation act for the expenses of state government, passed by the last session and approved March 7, 1891, provides as follows:

"For the Agricultural College, Experiment Station and School of Science, sixty thousand dollars (\$60,000): *Provided*, The amount herein appropriated should be returned to the state treasury from the proceeds of the first sale of lands donated to the state for the Agricultural College, Experiment Station and School of Science." Owing to technicalities and litigation this money has not been available until recently.

It is evident, by the terms of the clause quoted, that the intent of the legislature is to have this money returned to the state from the first appropriation made by the general government for that purpose.

This money is being used to pay the expenses of erecting and completing a dormitory and also a building to be used for class rooms, assembly hall, laboratory, museum, library and office. Subsequently this building will be used for department work.

We shall also complete, for temporary use, a one-story rustic wooden building of ample dimensions to accommodate our students in shop work with wood and metals, and for power house.

At present we are using, for class rooms, a one-story brick building thirty-six by sixty feet. This building has been completed and

paid for out of this appropriation at an expense of fifteen hundred dollars.

The only other expenses besides the erection and furnishing of buildings for the purposes of instruction and dormitory use, to be paid out of this appropriation, are the expenses of heating, regent expenses and per diem bills, and incidental expenses.

Since the first day of last March it has not been necessary, owing to securing the government appropriations for that purpose, to take any part of this appropriation for the payment of teachers' salaries, and before that date only a small amount, less than two thousand dollars, had been used for that purpose. This sum will cover the entire amount paid by the state, from this appropriation, in salaries to the present faculty.

The government appropriations provide means for payment of our teachers and professors which are entirely independent of state aid.

The dormitory is one hundred and four feet in length, with a frontage of fifty-seven feet and a rear of forty-five feet. It is built with brick, and the best of Washington material is used in its construction. It is five stories in height, including a basement and an attic.

It will be lighted with electricity and heated throughout with steam, and each floor will be provided with closets, bath rooms and water.

The basement consists of a dining hall forty-one by forty-two feet, a kitchen twenty-six by twenty feet, a pantry and china closet twenty by sixteen feet, a storeroom ten by sixteen feet, and two suits of rooms consisting of a living and sleeping room, each twenty-seven by twenty feet.

The four remaining floors will be provided with thirty-two suits of rooms, each consisting of a study and two sleeping rooms. Eight study rooms are twenty-three by ten feet each, with bedrooms ten by ten feet. Twenty-four study rooms are eighteen by eight feet each, with bedrooms nine by eight feet. Each suit is also provided with closets.

Each suit will be furnished with bedsteads, wire mattresses, chairs, study table, and washstands.

The students will be required to furnish bedding, towels, washbowl and pitcher, and carpet, if desired.

The dining hall and kitchen will be provided and fully equipped

for preparing, cooking and serving food, and also for giving instruction to young women in some branches of domestic sciences.

A gravity system of water works is now being completed, in connection with the experiment station, which will furnish an abundance of pure artesian water for use throughout the buildings.

The expenses of maintaining the institution are largely supplied by the general government, and as it is a state institution and belongs to the people, they should not, therefore, be required to individually pay for the advantages it has to offer. Tuition and room rent is free to each student who is a resident of the state.

DISCUSSION.

MR. MAYS: Can students arrange to board and room in clubs, thereby lessening expenses?

PRESIDENT LILLEY: Yes.

REV. WHITCOMB: What preparation is required for admission to the college courses of instruction?

PRESIDENT LILLEY: A good knowledge of the common school branches, consisting of arithmetic, English grammar, spelling, physiology, penmanship, geography, reading and United States history, is required before entering the first year of the College courses.

Any person not less than fifteen years of age, of good character, may be admitted to the College classes, in so far as his previous preparation fits him.

We have a preparatory department, consisting of a one year's course of instruction, connected with the College, in which a student may review the common school branches and obtain a good common school education, in case he is not sufficiently advanced to enter the College classes. Any person fourteen years of age, and who understands arithmetic through fractions; who can distinguish the parts of speech; who can read, write and spell reasonably well, and who is well grounded in the geography of the United States, can enter this course.

REV. WHITCOMB: What is the apportionment for the several counties, and especially for Garfield county?

PRESIDENT LILLEY: There is no apportionment; it is free to all alike.

The following papers were then read by the several members of the station staff:

FARM RESOURCES.

J. O'B. SCOBEY.

Should I undertake to cover the entire field opened by the subject of this paper, I much fear that it would require more time than is allotted me. I shall confine my suggestions principally to one item of resource upon the farm.

This northwestern State of Washington is a most wonderful country. The more one contemplates and studies it, the more does its great value as a wealth producing section impress itself upon the mind. Its resources are limitless. The state by a natural barrier is divided into two sections, in one of which the principal industries are lumbering, mining, the fisheries, fruit and dairy farming, while the other section is devoted very largely to general agriculture, fruit raising and dairying being included under such general term. While lumbering is at present the main industry of the western division of the state, wheat growing constitutes the principal crop of the portion east of the Cascades. Among the very few things that we may say are common to the entire state, to both of the divisions I have mentioned, is the dairy industry. It is, therefore, one of the pursuits in which all the people should have an interest.

The dairy industry has made more rapid improvement in the last few years than probably any other branch of agriculture. In what a few years ago were our principal grain growing and flour producing states, the sound of the sickle is now practically hushed, while the "lowing herd winds slowly o'er the lea" to nearly every farm yard in those states. The ceaseless march of empire from east to west has been no more certain than has the western advance of the cow, and we can truthfully say that the latter has camped each night upon the trail of the former, and while the cow has always kept, or rather been kept, by her unwise master, well to the rear of the advancing column of American progress and civilization, she has always sent forage on ahead to those who have left her behind. To-day she is performing that kind office for the State of Washington. From her prairie home in Iowa, Minnesota and Wisconsin,

she is supplying thousands of tables in Washington with her delicious products, and like Iowa, Minnesota and Wisconsin very foolishly did when the cows of Illinois, Indiana and Michigan were supplying them with butter and cheese, we are annually digging away at our soil, wearing it out with the utmost certainty, raising wheat to sell to get money to send back and buy the dairy products of those states. In due course of time we shall find out just as Iowa did that it don't pay; that there is more money in the dairy than in the wheat field, and instead of wearing out our lands, we can by dairying make them more fertile.

Dairying is probably the most profitable branch of agriculture. It is not the easiest, at least to one who is a stranger to the business. To one who places a premium upon intelligence, the work of the dairy soon becomes a lighter burden than the labor attached to wheat raising. To be sure, it requires the exercise of a certain amount and a certain grade of intelligence to raise wheat.

A man to raise wheat must know how to plow. Then he must be able to remember from one year to another how much seed he should sow per acre; and in a country where they raise as much smut as they do wheat he must know, or learn, how to treat his seed to keep the smut out. Then he should be able to drive a seeder middling straight over a hill, say one hundred feet high, have something of a knowledge of the intricacies of a twine binder and know the road to market in the fall, and he will make a fair hand at raising wheat.

It requires a higher grade and a larger degree of intelligence than this to make butter. But then, as I said before, it pays better.

The man who takes his ax into the woods and chops down trees and cuts them into saw-log lengths, commands, as a wage, from one to two dollars per day. He who squares the timber and saws it into boards and blocks is better paid, because he has brought to his work more and a higher grade of intelligence; but he who takes the board or the block and lays out upon it designs, which with a skilled and deft hand he carves into imitation flowers so perfect as to remind us of sweet perfumes, into forms of birds that disappoint us that they do not sing, into images which surprise us that they cannot speak, is the one whose compensation is limited only by the means of those who are lovers of beauty, of art and of intelligence.

So it is with all labor. The most skilled and the most intelligent always command the highest price.

Now, I do not want the members of this institute to believe that I have no regard for wheat or the wheat grower. I know that it was inevitable that it should be the first principal crop of this new country, and it is inevitable that it will be the main crop for some time to come. We are growing about twenty varieties of it now upon the College farm, and I have complained a great deal because we have not more land under cultivation to sow to wheat. We are thus experimenting with this crop because we know of this inevitable, and we want to assist in making it as good a crop as possible while it is grown here extensively.

But I know another thing, and that is, it is a "lazy man's crop." I have grown many a crop of it myself.

Now, what I most desire is to impress upon the minds of the farmers of this country, and particularly those of you who are here permanently, with fixed homes that will be your abiding places for many years or so long as you may live, that it will be necessary to turn to the dairy for support and for a competency. This country will not raise wheat always, any more than any other country will, and I want to get the people to thinking about the questions of good dairy cattle, good milk, good cream, good butter, good cheese and good profits. Every extra dollar earned by a farmer in this country or paid by a consumer for a product made here which he is now buying abroad, is a dollar added to the wealth of the state.

I have not come here to-day to discuss methods, or the details of butter making. I have come here to try and create an interest in this subject of dairying, to ask you practical farmers why it is not practicable in this section, and why we cannot even this year begin to prepare for it, and to improve our stock and our advantages, so that instead of buying the products of foreign herds, this country may soon be enjoying the balance of trade in that line in its own favor.

DISCUSSION.

MR. KIMES: The great drawback to dairying in this section is a lack of pasturage. If some one will give us a grass that will endure our long summer drouths, we can carry on this industry here with fair profits. With our native grasses as they are found on the ranges to-day, it takes about fifteen acres to keep one cow. We want an evergreen grass or some other summer forage crop.

PROFESSOR SCOBEEY: What cultivated grasses have you tried?

MR. KIMES: Several species have been tried. Among them we find that timothy and clover will not stand the drouths. Several others have been tried with varying results, but in no instance very promising.

PROFESSOR SCOBEEY: At the College we have about twenty varieties which were sown this last spring, and we shall make an effort to find the grass especially needed for this section — the summer forage crop.

MR. DAVIDSON: It is my opinion that we need a market more than a forage crop. At present we have not a staple market, and when butter drops from thirty-five to twenty cents per pound, the average farmer finds too little profit in its production, and consequently the home supply gets down to a very small, and probably a negative quantity. But if some one will insure us a good market, we will find pasturage and produce plenty of butter.

PROFESSOR SCOBEEY: From what I have been able to learn, there seems to be no reason why there should not be a ready market for all the choice butter that can be reasonably produced in this section. Tacoma dealers are obliged to go east of the Rockies for butter in quantity. They cannot afford to set up buyers in a section where only a few tubs of butter can be had. They must have car load lots, and when this section can furnish good prime butters in such quantities there will be plenty of buyers here eager to get the product of your dairies. The people of Pullman are obliged to pay from forty cents to fifty cents per pound for nearly all the butter they consume, which comes from Iowa and Wisconsin. It is the same in the other towns of this section, if the local papers and merchants are to be relied on. Why is not the local production sufficient for this local trade, to say the least?

MR. KIMES: One reason why no more butter is shipped is, that we are not able to get butter firkins at any reasonable figures. Our merchants here don't care to get them for us, and we can't ship in crocks.

PROFESSOR SCOBEEY: When once the dairy industry is well under way in this section, creameries will be established; the product will be of a uniform grade, and in this way at much less expense for labor and machinery a fine grade of butter will be produced,

which may be shipped direct from the creameries to the market centers of our coast and this great northwest.

MR. DAVIS: What breeds would you recommend for dairying?

PROFESSOR SCOBAY: This is a difficult question to answer, as even the best of our dairymen differ in opinion. I prefer the Jersey or Holstein. One may not be able to begin with a full blood Jersey or Holstein herd, but by introducing a few head of pure stock the herd may soon be graded up.

AZOTURIA.

DR. C. E. MUNN.

Azoturia is a disease which has been quite common in this country during the past few months, and, as it usually attacks horses of the better grade, we will attempt to give a brief description of its nature, causes and symptoms, with a practical method of treatment, and that which is of more value to the average horse owner, its prevention.

I will begin with a description of the symptoms of the disease. In nearly all cases the animal attacked is one in good form, and fine condition, generally one that has had regular work or exercise, but for some reason has been kept up for a day or two, or even longer, and during confinement given the same quantity and quality of food as when at work. He is brought out after this period of rest and put to work, or, at least, started, for although he starts out feeling and appearing in the best of health and vigor, he may not proceed more than a hundred yards, or perhaps a mile or two, before he will show symptoms of some trouble in the muscles of locomotion. If affected in a mild form, there may be a slight lameness of one limb, generally one of the hind legs; he has lost the vigor which was noticeable when he started out, and appears dull and lifeless, and, if forced to proceed, the symptoms become rapidly worse. In the more severe cases the lameness is increased and the affected animal may even lose entire control of the posterior extremities, and when forced to move a few steps reels and falls to the ground, giving the impression to one not familiar with the disease that he has in some manner injured his back. Other cases

show symptoms of colic, together with trembling and twitching of the larger muscles, more especially those over the the rump and loins. In nearly all cases there is a discharge of dark coffee-colored urine. In the more serious cases the animal refuses to eat or drink. In the milder forms the appetite is not impaired. The more severe cases may terminate fatally in from two to three days, but if the animal has not been allowed to exert himself after the first symptoms have been discovered, and is properly treated, a quick recovery may be expected, except in the more serious cases. In slow recoveries loss of power may occur in the hind extremities which may last for some time, and there may be extensive wasting of the muscles between the stifle and hip joints.

The cause of this disease is without a doubt dietetic. An abnormal amount of nitrogenous or albuminous material is taken into the system; the supply appears to exceed the demand, and not being utilized, remains in the circulation, chemical changes occur caused more especially by exercise, producing something of the nature of a poison to the nervous system, and affecting the larger masses of voluntary muscular tissue.

The treatment should be to remove as quickly as possible the cause. In mild cases, a laxative—as a small dose of aloes—and bran mashes with about one ounce of nitrate of potash per day. In more severe cases, a full dose of aloes, from six to eight drams, and every five or six hours two or three drams of bromide of potash, with one ounce of spirits of niter to calm nervous excitement and stimulate the kidneys to action. Fomentations of warm water over the loins, or thick woolen cloths wrung out of hot water, give great relief and favor secretion of the kidneys. In those cases where the animal is unable to stand, he should be given plenty of good bedding and turned from one side to the other three or four times each day, and after three or four days from the beginning of the attack, should be helped up if possible and kept standing twenty or thirty minutes, two or three times during the day.

During recovery care should be taken not to over feed and thereby disturb the digestive organs. Medicines to tone up the system, as *nox vomica*, one-half dram, with powdered gentian, two drams, should be given two or three times every day.

As it is evident that plenty of nutritious food and lack of exercise produce this disorder, we may reasonably expect to avoid it by care in feeding animals in high condition when off duty, and to

give gentle exercise before starting in at work after having been idle for a day or more. A horse that has had one attack should never be without exercise even for one day, and a restriction of diet is often necessary.

DISCUSSION.

MR. THOMAS: At what age are horses most liable to this disease?

DR. MUNN: Young horses that are growing and aged horses are comparatively free from it. Horses that have matured and are in good health and condition are the ones commonly affected.

MR. WALKER: Are mares more liable than male horses?

DR. MUNN: It is claimed by some authorities that it is a disease peculiar to mares, but that has not been my experience, and I believe that under the same conditions of food and exercise one sex is as subject to the disease as the other.

MR. JOHNSON: Does it ever happen as an epidemic?

DR. MUNN: It never has in my experience; although I have had a number of cases occur in a single stable and at the same time, simply because all were placed under the same conditions, receiving rich food and not enough exercise.

MR. MASON: Can a horse be worked out of the trouble after the first symptoms are exhibited?

DR. MUNN: It should not be attempted, for continued exertion almost invariably increases the severity of the symptoms.

PROFESSOR SCOBEY: Would some kinds of grain tend more to induce this disease than others?

DR. MUNN: Yes. Highly nitrogenous grains will bring on trouble in this direction sooner than lower grade grain.

After music by the orchestra, the Hon. F. W. D. Mays spoke as follows:

THE FARMERS' SONS THE HOPE OF OUR COUNTRY.

MR. CHAIRMAN, LADIES AND GENTLEMEN—It affords me great pleasure in an *impromptu* way to call attention to the fact that the most potent factors and most conservative element in the body politic of the past and of to-day, have been, and are, the influence

wielded by the sons of farmers. I suppose the students of history will not dispute this assertion when they recall the names of Washington and Lincoln, besides a host of others that could be mentioned. By reference to the work and deeds of the sons of the farmhouse of the past, I am warranted in assuming that the farmers' sons are the hope of our country for the future. In boyhood I climbed the same hills over which George Washington played and romped in his early life, and where in later years, after he was called from the plow to serve his country, he led the continental armies to victory over the most formidable foe of his day. It is not possible for any of the epochs of history made since the days of Washington, or to be made in the future, to eclipse or detract from the lustre of his name or deface the bright halo of glory that will forever wreath his brow and shine about his head at the mention of his name.

The late great civil war, for the emancipation of American slavery, would have been a failure but for calling Abraham Lincoln, the rail-splitter, who followed the plow barefoot in his youth, to guide the ship of state in those perilous times when brother was arrayed against brother contending for what both believed to be liberty under the constitution.

The youth of our cities, as a rule, so impair their mental abilities and degrade their manhood by evil habits, that they unfit themselves for successful leaders in great emergencies; and when these arise, some farmer's son who has brawn as well as brain is necessarily called, as was General Jackson, from the farm, to lead our armies to victory, and as Lincoln was to guide the ship of state.

Time would fail me to cite instances in proof of the position I claim for the farmer's son in history, and I declare that his services will be more indispensable in the future, since our city life, especially in the great marts of our country, are such as to inspire little hope of a high type of manhood to be developed in the youth of these centers of population, where exist the vices of city life.

The inauguration of the present system of our agricultural colleges and schools of science open a bright page in the history of our country that augurs well for the future. It is now possible for almost every son and daughter of our farmers to drink deep at the fountain of knowledge which flows through these schools, and be thereby prepared and fitted for duty in any emergency to direct which our country's needs may call them. And let me say in con-

clusion, that not the least among these potent factors stands our State Agricultural College, so ably presided over by its present faculty of aggressive, energetic and able instructors.

TREES AND TREE GROWTH.

E. R. LAKE.

To the dweller in this region of treeless wheat fields, trees have a thousand attractions unknown to him who passes his daily life among forest monarchs of many species, though the latter may not in the least underrate their value. How refreshing the shade of trees none but he who longs for it, yet cannot avail himself of it, can truly estimate. How agreeable the leeward side of even a narrow windbreak is, can only be told by him who has faced a Palouse wind for several hours and then been relieved for a short time by some sparse but protecting screen of trees. Who knows better than the older residents here the changes that greet one, both summer and winter, as he emerges from some cove or group of trees on a windy day? And yet, knowing all these advantages of trees, together with others equally valuable, what have our people been doing in the direction of tree planting? Why, practically nothing. Over these thousands of acres of rolling wheat fields there are scarcely more than a score of well tilled timber claims, orchards and small fruit gardens. It is true many thousands of trees have been planted, but large numbers of these have died out entirely or made such poor growth that they do our soil and climate, yes, and people, too, a grave injustice. Travel which way you will from any of our more populous towns, and timber belts varying in area from five to twenty acres will greet the eye; but what proportion of these are thrifty, well tilled belts or groves? Only a small proportion, so far as my limited observation goes. Now and then can be found one that even under a total lack of care has made a vigorous growth, producing in five to twelve years trees five to nine inches in diameter, and twenty to forty feet in height. On the contrary, many others have produced only weak, knurly trees, entirely unsatisfactory to the—cultivator, we ought to say; but the man who

has such a plantation, and there are no few of them, is not a cultivator in the best sense of the word; he is only an owner.

The average farmer seems to forget, or else has never fully realized, that most trees require more care than would be given to a wheat crop. A grain crop matures in a year, and every farmer knows the importance of preparing a good seed bed; but when he plants a tree, he apparently loses sight of the fact that this crop takes years to mature, and that thorough cultivation of the soil for a few years is no more work for this crop, relatively speaking, than is given to the preparation of the seed bed for the wheat crop; for, while the latter requires so much work each year for all time, the former only requires this attention to soil tillage for a few seasons covering the period of first growth, which period, though requiring a few years, corresponds with the germinating period of the wheat crop, so far as general crop growth is concerned, while for years to follow very little or no work is required to keep the tree crop growing and even fruiting.

The fact that the tree crop does not give immediate returns is one reason why it receives so little attention at the hands of the average cultivator. This, together with the indifference with which farmers in general look upon trees, shrubs and vines, underrating and belittling the work of caring for them, is ample cause for this neglect of the tree crop, and especially the forest tree crop.

Some figures collected during the past few days from orchards and windbreaks are interesting, as showing what cultivation will effect in tree growth. In a small, park-like plantation in the city of Pullman, located on bottom land, trees four years old that have been planted out two years and given thorough tillage, gave the following measurements:

Elms — No. 1, $7\frac{1}{2}$ feet high, trunk 1 inch, shoots 20 to 32 inches; No. 2, 8 feet high, trunk 1 inch, shoots 20 to 35 inches; No. 3, $8\frac{1}{2}$ feet high, trunk $1\frac{1}{3}$ inches, shoots 30 to 60 inches; No. 4, 7 feet high, trunk 1 inch, shoots 30 to 45 inches; No. 5, 8 feet high, trunk $1\frac{1}{2}$ inches, shoots 32 to 55 inches.

Poplars — No. 6, 11 feet high, trunk 2 inches, shoots 28 to 45 inches; No. 7, 12 feet high, trunk $2\frac{1}{3}$ inches, shoots 30 to 44 inches.

Buckeyes — No. 8, 4 feet high, trunk 1 inch, shoots 2 to 4 inches; No. 9, 6 feet high, trunk $1\frac{1}{4}$ inches, shoots 4 to 6 inches.

The measurement of trunks in all cases is taken two feet from the ground.

In a windbreak on a northeast hillside, the following measurements were taken as an average of several fair representatives of the trees there growing:

Box elders, not over six years old and 18 to 20 feet high, with a spread of from 8 to 12 feet; No. 10, trunk 3 inches, shoots 18 to 30 inches; No. 11, trunks $3\frac{1}{2}$ inches, shoots 18 to 36; No. 12, trunk $3\frac{1}{2}$ inches, shoots 20 to 40; No. 13, trunk $3\frac{1}{2}$ inches, shoots 18 to 44; No. 14, trunk 4 inches, shoots 20 to 45. Most of the shoots were from $\frac{3}{8}$ to $\frac{1}{2}$ an inch in diameter.

Some four-year ash trees gave data as follows: No. 15, $6\frac{1}{2}$ feet high, trunk 1 inch, shoots 12 inches; No. 16, 7 feet high, trunk $1\frac{1}{4}$ inches, shoots 14; No. 17, 8 feet high, trunk $1\frac{1}{2}$ inches, shoots 14 to 16. Spread of top in the above, about 6 feet.

Silver maples four years old in the same plantation were 12 to 15 feet high, with last year's shoots frequently 5 feet long and $\frac{1}{2}$ an inch thick.

Some four-year-old apple trees on a similar slope, but cultivated more thoroughly than in the above timber belt, made an average growth of two to two and a half feet on trees having trunks from one to two inches in diameter.

In all the above cases the trees presented a healthy, thrifty appearance, while the contrary in all respects was well shown in some measurements and observations taken in an untilled timber belt.

Observations made in one timber belt showed many of the box elder trees, on the south side of the plantation, entirely dead above ground, apparently winter killed; at the same time some ash trees of the same age but smaller, with the same care and exposure, were extremely healthy and vigorous in appearance. These trees had been fairly well cultivated, and it was charged that the clean cultivation had produced too prolonged growth in the fall. How near the truth this is has not yet been fully ascertained. But, however this may be, it is certain that pests and diseases have wrought far more devastation in the untilled and unpruned plantations. Broken down trees infested with fungous and insect pests are wide spread in the timber belts that have been left uncared for.

A point of no little significance in the consideration of the tree crop is that the trimmings from a belt of vigorous growing trees will afford the cultivator fuel enough to cover the cost of cultiva-

tion after the first two or three seasons. After some few years the more rapid growing trees will begin to return a revenue, for their cultivation will be stopped, and what fuel is taken from the belt either as branches in pruning or trees in thinning will be income from the crop. With the slower growing trees, and particularly the nut-bearing trees, it will be longer before returns in this form may be expected, but when they do come they will be all the more substantial. For, while these slower growing trees do not furnish a windbreak in so short a time, or show so large a quantity of wood in a given time, the wood is heavier, closer-grained and, consequently, bulk for bulk, of greater value.

From these figures we may learn one or two lessons regarding culture and tree growth that may be profitably studied by the average farmer who as yet has devoted no time and labor to his crop.

First, That our hardier forest trees make vigorous growth in this section when thoroughly cultivated.

Second, That untilled belts make very slow growth, even when composed of the hardier trees.

Third, That the trimmings from a well cultivated timber belt pay the cost of cultivating after the third or fourth year, and after the tenth or twelfth make some returns above all cost of care.

DISCUSSION.

MR. RUSSELL: What is the best shade tree for this section?

PROFESSOR LAKE: This is a question which Mr. Russell ought to answer for me, rather than I for him. However, from what I have seen in the vicinity of Pullman I should deem the American maples and elms as of first choice. They are not as rapid growers as some others, but they are hardy, fair growers; well shaped and very free from pests. Still, I should want more experience before advising would-be planters. Why our native trees, such as pines, firs, ashes, spruces, etc., are not more frequently planted, is a question with me. I deem many of our native trees very promising for shade, shelter and ornament, and would urge all intending planters to give some few of them at least a fair trial.

MR. RUSSELL: Generally, I think people hereabouts find the black locust does best as a shade tree.

A. A. OWSLEY: *I would like to know something regarding the smut that is found in our grains.

PROFESSOR LAKE: This smut is a plant, microscopic in size and parasitic in its nature. The part which we are most familiar with is the fruit of this plant. When one kicks an old or ripe "puff ball" or "toad stool," a cloud of dust issues. This dust is composed of numberless small bodies called spores. The spores are the "seed" of this smut plant, and taking this as the starting point, the life history of these plants may be briefly stated as follows: One or more of these spores becoming lodged on the threshed grain, are sown with it and germinate when it germinates. The spores throw out a root-like body which passes along over the surface of the grain and enters the young shoot of the wheat, for instance, as it comes forth. It is only during a brief period, just as the grain is sprouting, that this entrance of the wheat stem can be effected by the root-like growth of the smut. When this smut plant has entered the grain plant it begins to absorb from the sap or cell contents of the latter such material as it needs for its own growth. In this way it grows as the wheat plant grows, and when finally the wheat plant is ready to head out or form seed the smut plant is likewise ready to begin forming spores, and for this purpose absorbs more or less of the "milk" of the wheat. If the smut plant has not become a strong one it may only take from the wheat plant enough food for a kernel or two, or more, while, if it has become strong it may require for its use all the milk of a wheat head, thus making one or two smutted grains or all in a head, or several kernels in the heads of a stool of the wheat plant. The only remedy for this trouble is one of prevention. We are not made aware of the presence of this smut plant, or fungus, till it fruits or forms spores in the wheat head, and then it is too late, practically, to do any good, though the burning of all smutted heads would much lessen the danger of infection to the next crop. A general practice during the past few years among our more progressive farmers has been to soak the seed just previous to planting in a solution of blue vitriol; however, later experiments show that soaking the seed for a few minutes, not more than fifteen, in water heated to a temperature of 132° F., not lower than 130° and not higher than 135°. When the grain is taken from its hot bath cold water should be

*This question is discussed in Bulletin 3.

turned over it to keep from further heating. This treatment kills the smut spores and in no respect injures the grain but rather does it good, as it hastens germination. The advantages of the hot water treatment over the vitrioling is that the former costs nothing for material, requires about the same labor to treat and is rather more effective than the latter.

MR. OLIPHANT: †The wireworms are doing much damage to wheat in this section, and we would like to know how to treat them.

PROFESSOR LAKE: Professor Comstock has done some very thorough work in ascertaining the habits of this pest and best methods of fighting it. These "worms" are the larvæ of several species of beetles commonly called click beetles. They are particularly destructive because they live three years in this stage of their life. As you know, insects undergo three transformations. First they are larvæ or "worms;" second they are pupæ or chrysalids, and third they are beetles, moths, butterflies, bugs, etc. In his experiments Prof. Comstock found only one remedy worthy of recommendation, and that is *fall plowing*. When the older of these "worms" enter the next stage of their life—*i. e.*, become pupæ—they go down into the soil four to six inches and there, in a cell, undergo the transformations that make a worm a beetle. This they do usually about the early part of July. If the ground is turned over some few weeks after this time many of the cells in which the pupæ, or immature beetles, are found will be broken and the beetles, which at this stage are very soft and unprotected, are easily destroyed by exposure. After plowing, the soil should be thoroughly pulverized again and again. This treatment kept up for three years ought to well rid a field of this pest. Still it would be necessary to repeat at intervals. As it is difficult to plow land here so early in the season it may be delayed until the first fall rains come, but should not long be delayed thereafter as the beetles steadily again become less susceptible to the effects of the tillage. It is not necessary to withhold a crop from the land any year in order to carry out this treatment.

† Bulletin 4 treats of this question.

ATTENDANCE.

The following persons were in attendance:

Allen, A. B.	Freeman, W. L.	Long, J. H.
Allen, A. E.	Gilmour, Alex.	Legg, Amos.
Allen, C. P.	Gibson, R. G.	Mays, F. W. D.
Bond, J. W.	Gutka, Albert.	McEnnery, Wm.
Brown, G. W.	Geiger, Frank.	Mendenhall, A. H.
Bond, Thomas.	Gose, M. L.	Murphy, J. W.
Bookman, Charles.	Greene, W. E.	McMaster, J. R.
Burge, C. C.	Guth, Henry.	Moore, J. M.
Butler, D. C.	Gose, Dr. J. R.	Mulkey, L. P.
Bartels, J. F.	Graham & Kay.	Miller, Andrew.
Beck, John.	Hull, C. B.	McBride, D. H.
Baldwin, Z. A.	Hagy, J. H.	Mitchell, Lt. John.
Brady, Bert.	Herndon, F. P.	McBrearty, F. J.
Brockman, Chris.	Heaton, G. S.	McHone, L.
Benbon, H. C.	Hughes, J. G.	McCalley, W. W.
Burlingame, E.	Hunter, J. W.	Neibel, Mrs. Lizzie.
Brown, R. B.	Hanson, H. J.	Oliver, John.
Chappell, S. C.	Hull, S. K.	Owsley, A. A.
Chambers, Jos.	Hunt, Moses.	Oliver, E.
Campbell, G. L.	Hert, A.	Oliver, A.
Carter, W. W.	Henley, H. B.	Palmer, James.
Clary, Jos.	Hathaway, H. M.	Patterson, Mrs. N. S.
Cosgrove, S. G.	Hiller, Henry.	Robinson, C. G.
Cohn, Bernard.	Hawkins, J. B.	Rauch, E. M.
Dyche, T. J.	Irwin, R. A.	Stephens, J. A.
Davidson, J. O.	Jackson, G. F.	Scoggin, J. G.
Davis, A. D.	Jewett, J.	Scoggin, T. C.
Dixon, Jos.	Johnson, Emil.	St. George, Harry.
Dixon, Gilbert.	Jones, J. F.	Seeley, C. H.
DeBow, Mrs. C. H.	Kimes, Samuel.	Teale, E. G.
Davis, J. S.	Kansche, Henry.	Tyrrel, J. D.
Elsensohn, F. J.	Kenney, G. W.	Wise, H. H.
Eller, Geo.	Kassel, Mike.	Whitcomb, Lew.
Frank Bros.	Knettle, N. D.	Wilcox, M. J.
Ford, Albert.	Light, W. F.	Zimm, F. N.
Freeborn, W. S.	Lubking, J.	
Fox & Son.	Ledgerwood, C.	

All Bulletins of this Station are sent free to residents of the State.
Persons desiring their names on our mailing list should address

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PULLMAN, WASH.

STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 6.

HORTICULTURAL INFORMATION.

OCTOBER, 1892.

OLYMPIA, WASH.:

O. C. WHITE, . . . STATE PRINTER.
1893.

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HORTICULTURAL.

E. R. LAKE.

Bulletin No. 1 of this Station, among other things, stated that, so far as circumstances would permit, we would endeavor to make tests and experiments as follows :

HORTICULTURE.

“1. Local and general tests of the older and newer varieties of all the hardy orchard and small fruits.

“2. General and practical tests of cultural methods, with reference to localities and soil.

“3. The introduction and dissemination of the more promising fruits and nuts from foreign states, particularly Russia and Japan.

“4. The improvement, by selection and cross-fertilization, of our native fruits.”

BOTANY.

“1. A systematic study, including an exhaustive collection, of the state's flora.

“2. Local and general tests covering the introduction into cultivation of our native grasses, clovers and other forage plants, as well as the promising ornamental herbs.

“3. The establishment of a botanic garden wherein may be gathered, as nearly as possible, all the native plants of the state as well as some foreign ones.

“4. The thorough testing of grasses and other forage plants for the arid sections of the state.”

FORESTRY.

“1. A general study of the forestal conditions of the state, with special reference to forest preservation and tree growth.

“2. The testing of native and introduced forest and ornamental trees in the treeless portions of the state.

“3. The collection into an arboretum of all the native trees and shrubs of promising economic or ornamental importance.

“It will be understood that the above is only a general outline of proposed popular work. Each section embraces many specific questions, such as the selection of special varieties for particular localities and soils;

irrigation, in so far as it relates to orchard and garden crops; deep and shallow cultivation; winter protection of tender trees and herbs; pruning; evaporation and other methods of preserving fruits, etc., etc. So far as the strictly scientific work of this division is concerned, no definite plan of action can be formed until further information is gathered relative to the horticultural and forestal needs and resources of the state, and until much necessary preliminary work is done."

In accordance with this brief and necessarily incomplete statement of the work of this department, the following plantings have been made. Some observations have been taken; exchanges effected, and much other preliminary work done, which will be subjects for later bulletins.

ORCHARD FRUITS.

Apples.—Autumn Strawberry, Alexander, Arabskoe, Baldwin, Benoni, Benton, Ben Davis, Burlington, Bottle Greening, Boiken, Bogdanoff, Borovinka, Bogdanoff White, Cardinal Celina, Duchess, Danvers Sweet, Dominie, Edgar Red Streak, Early Harvest, Fallawater, Gano, Grimes Golden, Golden Sweet, Golden Russett, Golden Reinette, Hubbardston, Huntsman, Horse, Hyde's King, IXL, Keswick Codlin, Kronesh Rosy, Longfield, Lowell, Munson's Sweet, Mann, Maiden's Blush, N. W. Greening, Palouse, Pewaukee, Peter, Princess Louisa, Rambo, Red Astrachan, Rawles Janet, Romna, Scott's Winter, Sops of Wine, Stark, Salome, Sweet Bough, Shirk, Shipper's Pride, Sklanka Bog, Skruschapel, Talman Sweet, Tetofsky, Winter Fameuse, Windsor Chief, Winter Sweet Paradise, Wagner, Wealthy, White Pippin, Yellow Transparent; also numbers 399, 447, 185, 502, 3m, 135m, 252, 200, 38 vor, 378, 365, 442, 18m, 277, 980, 56 vor, 327, 379, 316, of Russian introduction by Iowa Agricultural College.

Crabs.—Transcendant, Gideon, Hyslop.

Apricots.—Alexander, Budd, Gibb, Shense, Unknown.

Cherries.—Amarelle Bunte, Abesse, Bigarreau, Black Tartarian, Belle Magnifique, Bessarabian, Brusseler Braune, Bänder, Dyehouse, Doppelte Natte, Elton, Early Richmond, Eugenie, Frauendorfer Weichsel, Galopin, Governor Wood, Girotte du Nord, Geo. Glass, Hunt, Heart-shaped Weichsel, Herzog Formeig Weichsel, Koper, King Amarelle, June Amarelle, Louis Phillippe, Lutovka, Morello, Montmorency Large, Markirsch, Maquoketa, Ohio, Ostheim, Ostheimer, Orel 27, Orient Kirsche, Orel Sweet, Orange Kirsche, Reine Hortense, 108 Riga, Red Muscateller, Smidt's Biggar, Sklanka, Spate Amarelle, Strauss Weichsel, Windsor, Wragg, Wagner, Vilne Sweet, Z 5 Orel.

Mulberries.—American, Downing.

Peaches.—Bokara No. 2, Nellie Noyes, North China, Stewart's Ironclad, Sargent, Wonderful.

Pears.—Autumn Garber, Bartlett, Bessemianka, Clapp's Favorite, Cole's Seedless, Chinese du Engery, Crassare Bergamot, Exeter, Garber, Idaho,

Kieffer, Le Conte, Lawson, Lawrence, Lucrative, Louise Bonne of Jersey, Margaret, Madeline, Mount Vernon, Moscow, Orel 15, Peffer No. 2, Sekel, Tyson, Wilder, White Doyenne. Also numbers: 4m, 1401, 418, 347, 391, 358, 345, 392 Zuckerbern, 107 vor, 396, 513, 12m, of Russian introduction by Iowa Agricultural College.

Plums.—Abundance, Beauty of Naples, Communia, Cheney, Chippewa, De Soto, Duane's Purple, Dame Aubert Red, Eaton,* Early Red, Forest Garden, Forest Rose, Griotte Precocce, Garfield, Golden Beauty, Gros, Mogul, Geuii, Hawkeye, Kelsey, Lombard, Moore's Arctic, Merunka, McLaughlin, Moldavka, Niagara, Orel 21, Orel 19, Orel 20, Pottawatomie, Pissardii, Prince Imperial, Quaker Beauty, Reine Claude, Richland, Rollingstone, Riga 113, Shropshire Damson, Saratoga, Simonii, Smith's Orleans, Spaulding, Trabesche, Wolf, Weaver, Wild Goose, White Nicholas, Yellow Gage, Yellow, 122.

Prunes.—Black, Petite d'Agen, Golden, Hungarian, Italian, Ungarish.

Quinccs.—Champion, Orange.

SMALL FRUITS.

Blackberries.—Agawam, Ancient Briton, Erie, Early Harvest, Early Texas, Kittatinny, Lawton, Snyder, Taylor, Wachusett's Thornless, Wilson Junior.

Currants.—Black Champion, Black Naples, Cherry, Crandall, La Versailles, Lee's Prolific, Red Dutch, Victoria, White Dutch, White Grape, White Gondoin.

Dewberries.—Lucretia, Natives.†

Gooseberries.—Crown Bob, Downing, Farragut, Houghton, Industry, Roesch, Smith's Improved, Whitesmith.

Raspberries.—Carolina, Cuthbert, Crimson Beauty, Carman, Earhart, Gregg, Golden Queen, Hillborn, Johnson, Marlboro, Ohio, Progress Pioneer, Palmer's Seedling, Philadelphia, Souhegan, Turner.

Strawberries.—Bubach No. 5, Cloud, Crawford, Charles Downing, Crescent, Cumberland, Dominion, Gandy, Glendale, Great Pacific, Great American, Haverland, Jersey Queen, Jucunda, Kentucky, Lady Rusk, Miami, Michel's Early, Miner's Prolific, Mount Vernon, Monmouth, Monarch, Mistress Cleveland, Old Iron Clad, Phillip's Seedling, Parry, Parker Earle, Sharpless, Wilson, Warfield, Yale.

LAWN PLANTINGS.

Chrysanthemums.—Mrs. E. D. Adams, Alcazar, Atlanta, Aquindick, Prince Alfred, Mme. C. Audignier, Mme. Bernard, Bohemia, M. Bourguignon, Mrs. Jessie Barr, Lillian B. Bird, Dr. Charles Brigham, Louis Boehmer, The Bride, Mme. F. Bergman, Mme. Bacco, Mrs. F. Clinton, Miss M. Colgate, Cleopatre, Colorado, J. Collins, Cortez, Circe, Cythere,

* Native from Colorado.

† From F. J. May, Avon, Washington.

Mrs. L. Cartridge, Miss M. Cartledge, Excellent, L. B. Dana, Jno. Dyer, Delaware, Daisy, Mrs. John Fogg, Flora Fewkes, M. H. de Fortanier, Mrs. A. Hardy, Grandiflorum, Eugenia Giat, Gold, Mrs. Grace Hill, E. G. Hill, Elk Horn, President Hyde, Jean Humphrey, Hartshorn, Ithaca, Iroquois, W. L. Kendall, Rose Laing, Harry Laing, Etoile de Lyon, Llewellyn, La Fortune, W. W. Lunt, Mme. Louis Langlois, W. A. Manda, Moravia, Grand Mogul, Marsalia, Mrs. T. F. Mercer, Annie Manda, Mariposa, Marvel, Harry May, Michigan, Monadnock, Miss Meredith, Magicienne, Orizaba, Onedia, Oswego, Ontario, Passaic, Jas. R. Pitcher, Mrs. J. C. Price, Violet Rose, Clara Riemen, Rohallion, Stanstead, Surprise, Shasta, Snowdrift, Snowball, Brazen Shield, Sachem, Tyro, Tuscola, Twilight, Mrs. G. B. Topham, Ulysses, Vieil Or, Val d'Andorre, Wichita, Crystal Wave, Frank Wilcox, Harry E. Widener, Yonitza.

Roses.—Marguerite de St. Amanda, Marie Baumann, Maurice Bernardin, Blanchefleur, Baron de Bonstetten, White Baroness, Baltimore Belle, Eliza Boelle, White Bath, American Beauty, Alfred Colomb, Magna Charta, Abel Carriere, Rev. J. B. Camm, Prince Camille de Rohan, Glory of Cheshunt, Centifolia, Countess of Chabriliant, Chenedolle, Anne de Diesback, Earl of Dufferin, Dinsmore, Abel Grand, Gracilis, Coupe d'Hebe, Mme. Hardy, John Hopper, Fisher Holmes, Mme. Jolly, Hippolyte Jamain, General Jacqueminot, Mme. Gabriel Luizet, Charles Lefebvre, Mrs. John Laing, Francois Levet, Jean Liabaud, Gloire de Margottin, Common Moss, Mabel Morrison, Blanche Moreau, Anna Maria, Charles Margottin, Francois Michelon, Jules Margottin, Paul Neyron, Mme. Noman, Pierre Notting, Countess of Oxford, Gem of the Prairies, Baronne Prevost, Queen of the Prairies, Mme. Plantier, Rugosa Rubra, Baroness Rothschild, La Rosiere, La Reine, Marie Rady, Countess of Serenye, Alphonso, Soupert, Lady Helen Stewart, Caroline de Sansal, Eugenie Verdier, Paul Verdier, Mme. Victor Verdier, Marshall P. Wilder, Persian Yellow.

Various other shrubs, vines and trees were planted for strictly ornamental purposes, but which at the same time will furnish desirable material for observation, comparison and experiment.

FOREST TREES AND SHRUBS.*

<i>Abies grandis</i>	Silver fir.
“ <i>balsamea</i>	Balsam fir.
<i>Acer pseudo-platanus</i>	Sycamore maple.
“ <i>dasyarpum</i>	Silver maple.
“ <i>macrophyllum</i>	Oregon maple.
“ <i>platanoides</i>	Norway maple.
“ <i>rubrum</i>	Red maple.
“ <i>campestre</i>	English maple.
“ <i>saccharinum</i>	Sugar maple.

*Several thousand of these were put into nursery rows, as nearly all were under one foot in height.

<i>Æsculus hippocastanum</i>	Horse chestnut.
<i>Alnus rubra</i>	Red alder.
<i>Amelanchier alnifolia</i>	Western serviceberry.
“ <i>oligocarpa</i>	Dwarf serviceberry.
<i>Asimina triloba</i>	Papaw, Wahoo.
<i>Berberis</i> , sp?.....	Barberry.
<i>Betula alba</i>	White birch.
“ <i>lutea</i>	Yellow birch.
<i>Buxus Sempervirens</i>	Box.
<i>Calycanthus</i> , sp?.....	—————
<i>Carpinus caroliniana</i>	Hornbeam.
<i>Carya alba</i>	Hickory.
<i>Castanea sativa</i>	Spanish chestnut.
“ “ <i>var. americana</i>	American chestnut.
<i>Catalpa speciosa</i>	Hardy catalpa.
“ <i>bignonioides</i>	Catalpa.
<i>Celtis occidentalis</i>	Hackberry.
<i>Ceanothus velutinus</i>	Elkbrush.
“ sp?.....	—————
<i>Cotoneaster Simonsii</i>	Rose box.
<i>Cornus Nuttalli</i>	Dogwood.
“ <i>sanguinea</i>	Dogwood.
“ sp?.....	—————
<i>Corylus americana</i>	Hazelnut.
<i>Cratægus tomentosa</i>	Haw.
<i>Cytisus scoparius</i>	Broom.
<i>Fagus americana</i>	Beech.
<i>Fraxinus viridis</i>	Green ash.
“ <i>americana</i>	White ash.
<i>Gymnocladus canadensis</i>	Kentucky coffee-tree.
<i>Juglans cinerea</i>	Butternut.
“ <i>nigra</i>	Walnut.
<i>Juniperus virginiana</i>	Savin.
<i>Larix americana</i>	American larch.
“ <i>europææ</i>	European larch.
<i>Ligustrum vulgare</i>	Privet.
<i>Negundo aceroides</i>	Box elder.
<i>Philadelphus Lewisii</i>	Syringa or Mock orange.
<i>Picea alba</i>	White spruce.
“ <i>excelsa</i>	Norway spruce.
“ <i>pungens</i>	Colorado blue spruce.
“ <i>nigra</i>	Black Spruce.
<i>Pinus strobus</i>	White pine.
“ <i>pungens</i> (?).....	Mountain pine.
“ <i>laricio</i>	Corsican pine.
“ <i>sylvestris</i>	Scotch pine.
“ <i>banksiana</i>	Jack pine.
“ sp?.....	Dwarf pine.
“ <i>austriaca</i>	Austrian pine.

Populus balsamifera.....	Balsam poplar.
" " var. candicans.....	Poplar.
" alba	White poplar.
" fastigiata	Lombardy poplar.
Prunus serotina.....	Black cherry.
Pseudotsuga Douglasii.....	Douglas fir.
Pyrus aucuparia	Mountain ash.
" americana	Mountain ash.
Quercus rubra	Red oak.
" prinus	Chestnut oak.
" sp?	Oak.
" alba	White oak.
Ribes sanguineum.....	Red-flowering currant.
Salix (several species).....	Willow.
Sambucus racemosa.....	Red-fruited elder.
Thuja occidentalis	White cedar.
" gigantea	Canoe cedar.
Tilia americana.....	American linden.
" europæe.....	European linden.
Tsuga canadensis	Hemlock.
Ulmus americana	American elm.
Virburnum opulus	Tree cranberry.

AN ORCHARD ENEMY.

It is exasperating and discouraging, to say the least, to the would-be orchardist who, after years of toil and great moneyed outlay, finds that his trees are not true to name. It is no less a discouragement to find after a similar lapse of time that his trees are weaklings, diseased from the roots up; in fact the latter is the more serious matter. For while a strong healthy tree of an undesirable variety may be made in a short time to bear abundantly of the desired variety, a diseased weakling will never give creditable results. Not only will there be a loss of time and money in the planting and care of the original trees, but the possibility and even probability that the germs of disease will be spread from the affected ones to the others, and thus injure a whole planting or even several plantings in the immediate neighborhood, is by far a more serious subject for consideration.

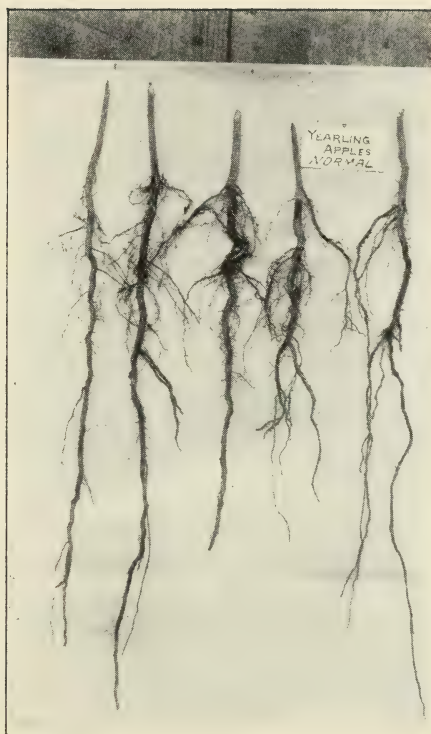
To the planter of apple trees in this Northwest there is no more serious pest than the woolly aphis. It is an insidious foe, one that creeps into the orchard and saps the life from otherwise promising trees, as stealthily as a midnight marauder, doing its first and most lasting work under cover of earth—in darkness. In other words, this pest makes its appearance on the roots of the young trees while in the nursery in many instances, especially in old nursery ground.

Having occasion to examine a quantity of apple seedlings for grafting purposes, it was observed that the larger part of them had twisted, tortuous and knotted roots. Some were slightly abnormal; others more so; while some were simply monstrous. Upon closer examination there appeared multitudes of little knots or excrescences of the size of a pin head and larger, intermingled with the larger ones, which latter ones were frequently as large as filberts. This was recognized as the work of the woolly aphis, and the whole stock as a result discarded.

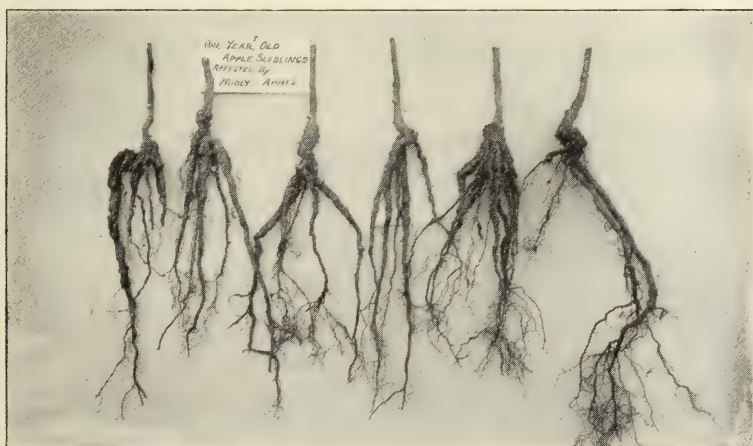
Last spring while planting yearling apple trees, purchased in the eastern states, the telltale “warts,” as the workmen called them, were found on several trees. It is needless to say the trees were at once destroyed, as it is safe to take no chances with such a foe.

Undoubtedly much of the trouble from this pest arises from its dissemination in this way — on the roots of young trees. The average planter is not familiar with the appearance of tree roots. He has not closely observed the difference between the excrescences caused by this pest and outgrowths caused by local injury, as by barking in cultivation.

For the benefit of those who are not familiar with the root effects of this pest we present the following cuts, taken from photographs of one year old seedlings grown on the coast. They were considered at the time they were taken, by those present, to be fair specimens of the normal and abnormal plants found in the examination above mentioned.



ABOUT ONE-TENTH NATURAL SIZE (UNAFFECTED).



ABOUT ONE-EIGHTH NATURAL SIZE (AFFECTED.)

DONATIONS.

During the past year the following named persons have made donations to the department as follows:

Department of Agriculture, Washington, D. C.: Samples of fruit of several varieties of almonds and chestnuts from Sicily.

Geo. Ruedy, Colfax, Wash.: Palouse apple, Shirk apple, Benton apple, Golden prune, Stewart Ironclad peach, Monstrous medlar, Prunus Simoni, Butternut.

C. S. Pratt, Reading, Mass.: Dozen strawberry plants.

Geo. W. Barkhuff, Colton, Wash.: Cions of Washington pear.

D. S. Grimes, Denver, Colo.: Abies Englemanni.

Dr. J. B. Pilkington, Portland, Ore.: Two Nellie Noyes peaches.

A. J. Eaton, Eaton, Colo.: Specimens of native plums.

Fred G. Blumhart, Corvallis, Ore.: Cions of seedling apple.

C. E. Hoskins, Newberg, Ore.: Cions of new prune.

Scott Morris, Spikenard, Ore.: Bulbs of Lilium Washingtonianum, plants of Ceanothus, Manzanita and Sugar pine.

F. J. May, Avon, Wash.: Plants of two varieties of dewberry.

Mark W. Johnson Seed Company, Atlanta, Ga.: Package of beans.

Idaho Pear Company, Lewiston, Idaho: Idaho pears and IXL apples.

Boothroyd & Tonneson, Tacoma, Wash.: *Northwest Horticulturist* for 1891.

E. W. Hammond, Wimer, Ore.: Pits of Prunus subcordata.

D. M. Ferry & Co., Detroit, Mich.: Package of beans.

—Roesch, Fredonia, N. Y.: Plants of new gooseberry.

STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 7.

DEPARTMENT OF ENTOMOLOGY.

TWO INJURIOUS INSECTS.

JANUARY, 1893.

All Bulletins of this Station are sent free to residents of the State.
Persons desiring their names on our mailing list should address

PRESIDENT, AGRICULTURAL COLLEGE,
PULLMAN, WASH.

OLYMPIA, WASH.:

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1893.

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TWO INJURIOUS INSECTS.

CHAS. V. PIPER.

THE PEA WEEVIL.

Bruchus pisi.

A number of inquiries have been received concerning this insect, which, for the first time reported in this state, was very destructive in several localities last year.

The insect causing the damage is a small oval beetle about one-sixth of an inch long, belonging to the family *Bruchidæ*, and can be distinguished from other weevils by its depressed head, short snout, and ten-jointed antennæ. Its color is a dingy black or dark grayish, more or less marked with white on the back. The elytra, or wing covers, are shorter than the abdomen, the exposed portion of which is white, with an oblong black spot on each side of the tip, so that the white portion somewhat resembles a wide letter T.

The beetles begin to appear about the time the peas are in blossom, and as soon as the young pods are formed the female proceeds to lay her eggs. She does this by cutting minute slits in the side of the pod and depositing a single yellowish egg in each slit. As this is nearly always done at night, the insect is but rarely seen during this operation. In a few days the eggs hatch into minute whitish larvæ or grubs, which immediately burrow through the pod into the pea opposite. The holes in the pod and pea rapidly heal, and in a short time the wound can scarcely be detected. After entering the pea, the grub grows rapidly, feeding on the soft tissues of the young pea, and at the time of harvest many of them have attained their full size. Just before reaching its growth the grub eats to the surface of the pea, but does not pierce the outer skin. At this time it is of a deep yellow color, excepting its black head. Before the end of summer the grub changes into the pupa, or quiescent condition. Some few of these pupæ hatch into the perfect beetles the same autumn, but in this latitude most of them re-

main in the peas all winter. If infested peas are examined in the spring, the "buggy" ones, as they are called, can easily be distinguished by the small, round black spot, which is seen on one side. Upon removing the skin of the pea the beetle is seen within, apparently awaiting an opportunity to come forth. If peas are not planted until late, many of them do emerge, but as a rule the insects are in the peas at the time of planting, and of course just where they will do the most damage as soon as the plants are old enough. As the grub but rarely injures the germ of the seed, "buggy" peas will sprout as well as perfect ones, but do not produce such strong plants.

REMEDIES.

As most of the weevils originate from the planted seed, it follows that only clean seed must be planted, or else the insects in the seed must be destroyed before planting. Any one of the following methods will be found effective:

1. Enclose the seed to be treated in an air tight box or other container, and pour in a small amount of bi-sulphide of carbon, which can be obtained at any drug store. Keep the vessel tightly closed for twenty-four hours, by which time the fumes will have killed all the weevils. Only a small amount of the bi-sulphide of carbon is needed, an ounce being sufficient for a bushel or more of seed. This method is used by most seedsmen. Great care should be taken with this substance, as its fumes are very explosive. Do not use it near a fire or exposed flame of any kind; even a lighted pipe is sufficient to cause an explosion.

2. If the seed be put in water at a temperature of 145° , for from one to two minutes, all the weevils will be destroyed without injuring the germinating powers of the seed. Oven heat of the same temperature will accomplish the same end.

3. The seed may be kept two years in tight bags or boxes. All the beetles emerge during the first year and die before the next spring. Peas two years old will sprout quite as well as those one year old.

Some farmers separate "buggy" peas from sound ones by placing them in water, when a large proportion of the infested seeds will float. This is not a sure method, even if all the peas that float are destroyed.

Prof. Weed, of the Ohio Experiment Station, found that most of the weevil grubs were but half grown at time of harvest. There-

fore, by heating the peas as soon as harvested to a temperature of 145° for one and one-half minutes, the weevils will not only be destroyed, but a considerable part of the edible portion of the pea saved.

It is useless to spray the pea vines with any insecticide for pea weevils, as being in the interior of the pods and peas, they are out of reach of the poison.

Finally, remember that your peas may become infested from your neighbor's; so see to it that he takes the same precautions as you do.

THE COTTONY MAPLE SCALE.

Pulvinaria innumerabilis.

This disgusting insect has increased very rapidly in Western Washington in the past few years, and is now found in many localities. During early summer it is very conspicuous owing to the white fluffy substance under the gravid female, and it is at this time that it attracts most attention.

The insect is a native of the eastern United States, and has been known for many years; but in the East the insect has usually been held in check by its natural enemies, which, though numerous enough in this state, have not been effective.

The life history of the insect is as follows: During May and June the female lays her eggs, usually over a thousand in number, in a mass of white waxy fibres, secreted from the posterior end of her body. As the eggs develop, they expand the waxy mass and raise the insect's body to a considerable angle with the twig upon which it rests. The eggs soon hatch into active larvæ, resembling lice, which run about over the plant. After the last eggs have hatched, which is usually early in July, the female dies, though the tough scale and the cottony substance cling to the branches for a long time. The young lice finally settle themselves along the veins of the leaves, commonly on the under side, insert their beaks, and begin to suck up sap. They increase in size rapidly, after having covered themselves with a tough waxy substance for protection, and reach their full size during August. About this time the males, which can be distinguished from the females by their narrower form, change into a pupa and soon after issue forth as a

winged insect. The winged males live but a few days and then die, after having paired with the females. The females never become winged and seldom, if ever, leave the branch on which they are born. On the approach of autumn the remaining insects, which are all fertile females, migrate from the leaves and fix themselves to the smaller branches, nearly always on the under side. After the sap ceases to flow they remain dormant until spring, when the round of life goes on as before.

In Western Washington we have observed the insect on the following cultivated plants, viz.: Currant, gooseberry, plum, pear, hawthorn, mountain ash, Lombardy poplar, and weeping willow; and these natives, the flowering currant (*Ribes sanguineum*), the upland willow (*Salix flavescens*), and the swamp willow (*S. lasian-dra*).

In the east it attacks many other trees, notably the silver maple, but strangely enough we have never found it to attack our native maple (*Acer macrophyllum*), or the sycamore maple (*A. pseudo-platanus*), both of which are abundantly planted as shade and ornamental trees. So, in this state at least, the name, cottony maple scale, would seem to be a misnomer.

As the female never becomes winged, it seems at first sight to be difficult to account for the spread of this insect, and as a rule it does spread but slowly, as everyone who has an infested tree on his place may have noticed. Careful observations have revealed the fact that the young lice are carried from tree to tree principally by clinging to the feet of birds, to spiders, or to other insects, and much less rarely, by the wind. Planting infested trees among others has also done much to spread this insect.

An infested tree always attracts numbers of other insects, such as ants, which feed on the sweet substance, called honey dew, that exudes from the scales; and numerous lady birds, which feed on the young lice. A lampyrid beetle (*Podabrus comes*), is also very abundant, together with many ichneumon flies.

The best method of controlling this insect is to spray during May and June with kerosene emulsion, which will destroy both the eggs and young lice. As the egg laying period lasts so long, two sprayings will probably be necessary; one about two weeks after egg laying begins — which is when the white cottony substance is first seen — and the other, two or three weeks later.

In the case of currants and gooseberries, the first spraying should

be when the fruits are well grown, but before they begin to ripen; the second, after the fruit has been picked.

It is useless to spray after the lice have formed scales over them, as they are then well protected. A winter wash of some lye solution is effective, but makes laborious work to apply it thoroughly.

The best kerosene emulsion is made as follows, as formulated by Dr. C. V. Riley:

Kerosene	2 gallons.
Water.....	1 gallon.
Common soap or whale oil soap.....	$\frac{1}{2}$ pound.

Boil the water, together with the soap, and pour boiling hot into the kerosene, churning violently with a force pump and spray nozzle, until the mixture reaches the consistency of cream. If properly made, the emulsion will stand without free oil rising to the surface. For ordinary use, dilute with water, using one gallon of the emulsion to nine gallons of water.

The formula of Prof. A. J. Cook, of Michigan, is preferred by some to the Riley mixture. It is as follows:

Kerosene	1 pint.
Water	2 quarts.
Soft soap.....	1 quart.

One-fourth pound of hard soap may be used instead of the soft soap.

Dissolve the soap in warm water and mix with kerosene, churning thoroughly with a force pump or syringe until it becomes a thick, creamy mass.

For use, dilute until only one-fifteenth of the mixture is kerosene; that is, add to the above amount of the emulsion ten pints of water.

Many complain that the kerosene emulsion kills the leaves. The trouble is that it has not been properly prepared. Some people try to make the emulsion by churning with a broad stick, which method rarely, if ever, makes a perfect emulsion.

If any free oil whatever arises on the emulsion, it is not properly prepared, and it would be far better not to use it. By following the above formula carefully, success is certain, the main point being to churn thoroughly and violently.

In spraying it is well to remember that one thorough application is worth half a dozen which do not drench the tree completely.

A FEW WORDS TO FARMERS.

This Station earnestly desires that all farmers and gardeners communicate with us concerning any and all injuries caused by insects, and solicits your aid and coöperation, that the work here may be supplemented by reports and observations from all parts of the state. It is only by this means that this station can hope to accomplish the best results; for, diversified as our farming interests are, it is impossible to combine them all on one farm or in any one portion of the state. We want every farmer to write concerning the injurious insects of his section; we desire to know what remedies you have tried and whether they have proved successful or not; we particularly want to be informed whenever you find an insect, new to you, causing damage. We hope by this means to get a definite idea of the more pressing needs of Washington farmers toward the control of dangerous insects. Just as far as we are able, we will take pleasure in answering all inquiries concerning insects, injurious or otherwise.

SOME FACTS ABOUT INSECTS.

Most insects can readily be distinguished by the mere fact of their having six legs. Spiders, mites and ticks have eight legs, and are not insects. All insects pass through four more or less well marked stages of existence; first, the egg; second, the larva, variously known as caterpillar, maggot, grub, and frequently, but improperly, "worm;" third, the pupa, which is usually quiescent and dormant, though not rarely active and much like the larva in appearance; fourth, the imago, or perfect insect. The larvæ of insects are in most cases destructive, the pupæ but rarely so, and the perfect insects frequently so. Some few insects are destructive in both larval and perfect stages. When the complete life history of an insect is known, it can then be attacked at its most vulnerable point, which may be in any one of its four stages; and if necessary in all of them. To this end all observations on insects, of whatever nature, are of value; indeed, some apparently trivial fact may furnish a clue to the best method of controlling the insect. Farmers should learn to distinguish beneficial insects, so that in the war against pests they may not be needlessly destroyed. Ladybirds, all ground beetles, and the ichneumon and chalcid four-winged flies are the best of the friends of the agriculturists and destroy hosts of

pests. Indeed, many dangerous insects are held entirely in check by their natural enemies, though it must be admitted cultivation gives the former advantages and at the same time militates against the latter. Unfortunately, also, spraying with insecticides destroys both the good and the bad, but this cannot be avoided. Inquiries concerning insects should always be accompanied by specimens, the more the better.

DIRECTIONS FOR SENDING INSECTS.

Adult insects should first be killed, which can best be done by placing them in alcohol for an hour or so, or by putting them in a tight jar with a few drops of chloroform. Then place the specimens in a close tin or wooden box, packing them in cotton or some other soft material, so that they will not be broken.

All larval forms should be sent alive, care being taken to put with it a supply of its food plant, enough to last at least two days. Do not punch holes in the box, as insects require very little air. If it is not convenient to send the larva alive, kill it in alcohol and pack in cotton saturated with alcohol. The mailing rate on all packages of insects is one cent per ounce. To accompany the specimens, write a letter containing all particulars concerning the insects, such as, the date of its appearance; numbers; the part of the plant attacked, whether root, stem, leaf, flower or bud; the remedies, if any, which you have tried; and, indeed, any notes whatsoever concerning the insect. These may be of great practical as well as of scientific value. All packages should have the name of the sender plainly written on the outside, and should be addressed to the Entomologist, Agricultural Experiment Station, Pullman, Washington.

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FALL SESSION OPENS SEPTEMBER 13, 1893.

For further information, address

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EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 8.

Common Fungous Diseases and Methods of Prevention.

DODDER.

JUNE, 1893.

OLYMPIA, WASH.:

O. C. WHITE, STATE PRINTER.

1894.

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COMMON FUNGUS DISEASES AND METHODS OF PREVENTION.

CHARLES V. PIPER.

Fungus diseases of plants annually cause the loss of many millions of dollars to the farmers of the United States. Within the past six years it has been abundantly demonstrated that much of this loss can be prevented by certain chemical fungicides at so small a cost as to leave the farmer a handsome additional profit. While the losses from these diseases in this state have not been very serious, they have been severe enough to demand earnest attention. Thus far, either from a mistaken idea of the amount of damage really done, or from ignorance regarding methods of treatment, none of these diseases, with the exception of the grain smuts, have received any attention whatever from the farmers of this state. The purpose of this bulletin is to describe in a brief and popular way the more common diseases of this character which occur in the state, and the methods of treating them which have proved most successful.

All fungus diseases are caused by minute lowly-organized plants called fungi. Fungi are plants in every sense of the word. For instance the fungus causing the "black knot" of the plum is just as much a plant as the plum tree itself, though immensely lower in the scale of nature. Fungi are entirely destitute of the green coloring matter, chlorophyll, which most plants possess, and upon which their power to change inorganic matter into vegetable tissue depends. Therefore, fungi can live only on such matter, either living or dead, which has already been elaborated by other plants, or animals. Depending on whether fungi obtain their nourishment from dead or from living matter, they may be divided into two groups, namely: those which live on dead matter, or *saprophytes*, such as mushrooms, moulds, etc.; and those which exist on living plants, or parasites. It is the latter class, the parasitic fungi, that cause most plant diseases, and with which we have to deal.

The vegetative body of these fungi consists entirely of very minute, transparent threads, termed *hyphae*, which ramify over the surface of, or between, the cells of their host plants, robbing them of their juices mainly by minute sucking organs.

This continual drain on the resources of the host seriously impairs its vitality, and frequently causes the death of the tissue attached, or distortions; in other cases the whole plant succumbs to the attacks of the fungus.

All fungi reproduce themselves by bodies called *spores*, which for all practical purposes answer to the seeds of higher plants; most species produce two, or even more, kinds of spores at different seasons. Those earliest formed are called summer spores, or *conidia*, and by their vast numbers and extreme lightness serve to spread the fungus very rapidly; other spores, called resting spores, are more complex in character, and tide the life of the fungus through the winter.

In many cases the weather has a marked effect on the appearance and abundance of fungus diseases, but it is in no case the cause of any of these diseases, as still so commonly supposed. Just as certain conditions of moisture and temperature are favorable to all plant life, so they are to fungi, only in the case of the latter the effect is much more marked.

It has been found that in the presence of certain chemicals, notably the copper salts, that spores will not germinate, and it is upon this fact that the efficacy of the fungicides rests. It must be borne in mind that fungicides are preventives only; not cures in any sense of the word. It is equally out of the question to instil life into tissue killed by fungi, or to kill fungi which are inside living tissue without injuring the host as well; all we can do is to prevent the plant tissue from becoming diseased or killed by preventing the germination and growth of the spores, and this is accomplished by keeping the plants covered with fungicides until danger of attack is over. It is a very common mistake to delay applying fungicides until some sign of the disease is visible. The mere fact that the disease is visible, shows that damage has already been done, which the earlier application would have prevented.

A number of different chemical mixtures have been used as fungicides with more or less success, but as there is little to choose from regarding the cost, we give formulas for the two best known, most used, and probably most efficacious.

BORDEAUX MIXTURE.

Copper sulphate.....	6 pounds.
Lime.....	4 pounds.
Water.....	22 gallons.

Dissolve the copper sulphate, pulverized, in four gallons hot water; in another vessel slack the lime in four gallons water. Mix the two together, stirring constantly, and strain through a coarse cloth, such as burlap. Then add fourteen gallons more of water.

A combined insecticide and fungicide can be prepared simply by adding Paris green or London purple at the rate of one pound to 200 gallons of the above mixture.

AMMONIACAL SOLUTION OF COPPER CARBONATE.

Carbonate of copper.....	5 ounces.
Ammonia water (26°).....	3 pints.
Water.....	40 gallons.

Dissolve the carbonate of copper in the ammonia, using more of the latter if necessary; then pour the solution into the water.

For a combined fungicide and insecticide never add Paris green to this mixture, as the ammonia disintegrates it. London purple may, however, be safely added. Mix one pound of London purple and one pound lime into a paste and add to 200 gallons of the mixture.

While we have in most cases recommended the Bordeaux mixture, the ammoniacal solution of copper carbonate is almost equally effective; it is perhaps even better to use in the later sprayings on fruit trees, as it leaves no coating on the fruit, such as the Bordeaux mixture sometimes does.

Both of these preparations should be made up only as needed, as they are most efficacious when fresh.

The wholesale cost, in the cities of the state, of the materials required is as follows:

Copper sulphate, 100 lb lots.....	6c. to 7c. per lb.
Copper sulphate, small lots.....	7c. to 8c. per lb.
Copper carbonate.....	40c. to 45c. per lb.
Aqua ammonia (26°).....	12c. per lb.
Lime.....	\$1.25 per barrel.

SPRAYING APPARATUS

Is now so commonly used that little need be said concerning it. Many styles of pumps and conveyances for the same are made by manufacturers to meet the requirements for all the various uses that

spraying machines are likely to be put to. The main point to insure proper spraying is a good nozzle. This should be so constructed as to throw a fine, even spray which will thoroughly wet the foliage without drenching it, and to be easily cleaned when it becomes clogged. The only nozzle that completely fills these requirements is the Vermorel, which, not being patented, can be bought of any dealer. This nozzle throws the spray only a short distance, but by attaching it with sufficient hose to a light, strong pole this difficulty can be obviated when necessary. The following reliable firms manufacture spraying apparatus, and will send catalogues on application:

The Field Force Pump Co., Lockport, N. Y.

The Nixon Nozzle and Machine Co., Dayton, Ohio.

William Stahl, Quincy, Ill.

The Gould's Manufacturing Co., Seneca Falls, N. Y.

W. & B. Douglas, Middletown, Conn.

Rumsey & Co., Seneca Falls, N. Y.

Deming Co., Salem, Ohio.

F. E. Myers & Bro., Ashland, Ohio.

William Boekel & Co., 518 Vine street, Philadelphia, Pa.

LOOSE SMUT OF OATS.

Ustilago avenae, (Persoon .

This disease is too well known to need description. The visible part consists entirely of masses of black spores. Under the microscope these appear deep brown in color and nearly globular in shape, with thick walls covered with very minute projections. Most of these spores are blown off by the winds before harvest and scattered through the field, so that more or less of them are invariably harvested with the oats. It is the spores which cling to the seed oats from which the smut of the next year is produced. When the seed oats germinate the smut spores also germinate, and within a few days the germinating tube of the latter forces itself into the young oat plant and thereafter continues to grow entirely within the tissues of the oat plant and to absorb its nourishment therefrom. The smut plant grows upward in the tissues of its host, and when the blossoms of the oat break from their sheath the young kernel of the oats and a great deal of the husks are seen to be converted into masses of spores, their substance having been absorbed by the smut plant for this purpose.

STINKING SMUT OF WHEAT.

Tilletia foetens, (Berkeley & Curtis).

There are two distinct but closely allied fungi which produce stinking smut in wheat, of which we have seen only the above in this state. The general characters of this smut are quite similar to those of the oat smut, but it is not at all conspicuous in the field, as only the kernel of the wheat is transformed into spores. The affected heads can usually be detected on close examination by being darker in appearance than the healthy ones. On crushing one of the affected heads between the fingers a very disagreeable odor is exhaled, which has been compared to that of decaying fish.

The life histories of these two smut fungi are practically identical. In both cases the host plants become affected from the spores which cling to their seeds. It follows then that if these smut spores can be destroyed without injuring the seed a crop free from smut must result. This is accomplished by most of our farmers by

The Copper Sulphate Treatment.—By this method the seed grain is immersed in a solution of copper sulphate for a greater or less time according to the strength of the solution used. The proportion advised by Kellerman and Swingle, whose experiments on grain smuts have been most exhaustive, is one pound copper sulphate (pulverized) to 24 gallons water. Allow the seed to remain in this solution 12 hours, after which it should be put from five to ten minutes in lime water, made by dissolving one pound good lime in ten gallons water. Then spread the grain out to dry. A weak solution of copper sulphate like the above is much to be preferred to the stronger ones commonly used, as the latter seriously injure the germinating powers of at least a portion of the seed.

The Hot Water Treatment.—The efficacy of this method rests on the fact that water at a temperature of 130 to 135 degrees Fahrenheit completely destroys the smut spores without injuring the seed grain in the least; indeed the germinating powers of the latter are considerably increased.

To properly treat seed by this method requires two large tubs; the first to contain water at a temperature of from 120 to 130 degrees and the second to contain water heated to 132½ degrees. A thermometer is indispensable to regulate the temperature. Put the seed to be treated in a wicker basket or in a coarsely woven gunny sack and allow it to soak for a few minutes in the first tub, or until thoroughly wetted. Then remove and plunge in the second tub,

stirring or kneading the grain so that each single one becomes thoroughly scalded; continue this for 15 minutes. The most important point is to keep the water in the second tub at the temperature of $132\frac{1}{2}$ degrees, never allowing it to go below 130 or above 135 degrees. In the former case the smut spores would not be killed; in the latter the grain seed would be injured. About half a bushel is all that can be treated properly at one time in an ordinary large tub.

As soon as the scalding process is over, the seed must be cooled by plunging in cold water or by some similar method and at once spread out to dry.

We urge the farmers to use one of these two methods in preference to the stronger solution of copper sulphate so commonly used, and recommend the hot water treatment as the best, as well as the cheapest.

Loose smut of wheat, which occurs only sparingly in the state, cannot be prevented by any known method.

POTATO ROT.

Phytophthora infestans, (Montagne).

The well known potato rot is a recent introduction into the state, and so far as our correspondence and observations show, is even yet found only in the western part.

The disease first becomes noticeable, usually in August, by the appearance of irregular brown spots, which rapidly enlarge and soon cover the leaves and stems, causing their death. On the under side of the brown spots may be seen a mildew-like growth, the fruiting threads of the fungus, which produce vast numbers of spores.

The tubers become affected through the stems, or more frequently, especially in wet weather, by the spores, which are washed down to them.

The treatment of the disease is entirely preventive, and consists in spraying the vines with Bordeaux mixture. The first application should be made very soon after the middle of July; the others at intervals of two or three weeks. If one knows the disease from its first appearance, the first spraying may be delayed until the disease actually appears. This will require close inspection daily of every part of the field, as the disease spreads very rapidly, especially if the weather is moist.

Care must be taken also to distinguish the genuine rot from a second disease of potatoes which we have found abundant in some parts of Western Washington. This disease is caused by the fungus *Macrosporium Solani* E. & M., and can be distinguished from the genuine rot by the following facts:

1. It appears much earlier, usually early in July.
2. The spots it causes are more or less circular in outline, and increase in size but slowly.
3. The spots are seen on close inspection to contain a series of concentric rings, giving it, as has been suggested, a target-board appearance.
4. There is never any mildew-like growth associated with the spots.

Even in fields where this fungus is abundant it seems to cause but little damage. The leaves are not very seriously injured and the tubers are not at all attacked by it.

POTATO SCAB.

Oospora scabies, Thaxter.

The cause of potato scab has long been a subject of controversy, and many theories have been offered in explanation of it, such as mechanical irritation of the soil, corrosion by lime or other chemicals in the soil, or by manures. It is now definitely settled that most of the scab, in this country at least, is caused by a fungus, which, by its irritating effects, causes the potato to develop the thick, corky covering that gives it the scabby appearance.

Manures may, and frequently do, contain the spores of the scab fungus in abundance, especially when scabby potatoes have been fed to the stock, or even when they are allowed to grow on the manure heap. Such manure, when applied to the potato field, will cause scab in the crop, and from this fact arises the prevalent idea that scab is caused by the manure itself.

While the value of the potatoes as food is perhaps not injured, their keeping qualities are, and on account of their unsightly appearance their market value is lessened. The spores of the scab fungus live for several years in the soil, so that infected ground is sure to produce a more or less scabby crop.

A perfectly clean crop can always be grown on land free from scab germs if the seed potatoes are free from scab.

If it is necessary to plant scabby potatoes they should be subjected to the following treatment, which will destroy the scab spores without injuring the potato: Dissolve three ounces of corrosive sublimate in three gallons of hot water. When entirely dissolved, pour into a tub or other wooden vessel containing seventeen gallons of water. Before treating the seed potatoes discard such as are deeply scabbed; then place the rest, a half bushel at a time, in a coarse gunny sack and allow them to remain an hour and a half in the solution. Care should be taken in handling the corrosive sublimate, as it is a most violent poison. The solution should always be placed in wooden vessels, as it corrodes metal very rapidly.

APPLE SCAB.

Fusicladium dendriticum, (Wallroth).

This attacks the leaves and young twigs as well as the fruit. On the leaves it produces velvety spots of a dark olive green color; on the fruit it produces dark roundish spots, which, when numerous, distort the fruit badly or even cause large cracks.

The fungus lives over winter on the young twigs, or on the dead fallen leaves, and early in spring produces numerous spores from which the leaves and young fruit become infected.

The damage caused by the fungus consists mainly in the unsightly appearance of the fruit, which seriously impairs its market value; in very bad cases, a considerable amount of the fruit may drop off while very young.

The disease can be almost entirely prevented by three or four sprayings with Bordeaux mixture. The first of these should be given before the buds open; the second shortly after the blossoms fall, and the others at intervals of two weeks.

By combining Paris green at the rate of one pound to two hundred gallons of the mixture in the second and subsequent sprayings, the damage caused by the codling moth will also be largely prevented.

TWIG BLIGHT OF THE PEAR AND APPLE.

Bacillus amylovorus, (Burrill).

This blight is caused by one of the bacterial fungi, the minutest of organisms. The particular species causing this disease is known as *bacillus amylovorus*, and it exists in enormous numbers in the diseased twigs and leaves.

Ordinarily, diseased twigs can be distinguished by the yellowish, thickened leaves, which drop prematurely, leaving the twig nearly bare except for the bunch of younger leaves near the summit.

The disease always appears first on the youngest twigs, and only a few of these on a tree may be diseased. Diseased twigs or branches seldom bear fruit.

Through the researches of Waite it has been demonstrated that the disease is carried from tree to tree by insects, mainly bees, and that the first infection takes place in the nectaries at the base of the flower petals. From here it spreads through the whole blossom and thence to the twigs and branches until the whole tree becomes affected and finally dies.

As the cause of this disease is mainly inside the tissues of the plant, spraying is of little use. A thorough pruning of the diseased twigs and branches faithfully followed up will hold the disease completely in check. The twigs or branches should be cut some distance below the disease and the prunings afterwards gathered up and burned. Care should be taken to disinfect the pruning shears by dipping them occasionally in a solution of carbolic acid; otherwise the disease may be spread to healthy branches or trees. When a tree is completely diseased it should be dug up and burned.

PEAR SCAB.

Fusicladium Pyrnium, (Lib.).

This fungus is a very close relative to that causing apple scab, and the injuries are similar.

It can be prevented by the same treatment recommended for apple scab.

LEAF BLIGHT OF THE PEAR.

Entomosporium maculatum, Lereille.

This disease attacks the fruit and young stems as well as the leaves of the pear. On the leaves it appears as numerous small spots, deep red in color, with a small black pustule in the center; on the fruit the spots are similar, and when numerous cause the pear, by checking its growth, to crack.

The main injury from the disease rests in the premature fall of the leaves, and sometimes by the distortion and falling of a considerable portion of the fruit.

The fungus lives through the winter mainly on the fallen leaves, so the gathering and destroying of these is advisable.

Four sprayings with the Bordeaux mixture, the first just before the buds open, the second after the blossoms fall, followed by the others at intervals of two weeks, will prevent most of the damage caused by the fungus.

PEACH DISEASES.

None of the diseases of the peach which we have seen in the state are serious enough to demand treatment. The two commoner ones found are the following:

PEACH LEAF CURL (*Taphrina deformans*, Berkeley).

This causes the leaves to become red and thickened and much distorted. A rapid change of temperature frequently causes the disease to appear in abundance. The fungus is too deep seated to be much affected by fungicides, but the disease is seldom of sufficient importance to demand it.

PEACH MILDEW (*Sphaerotheca* sp?).

This is sometimes common in early summer, fairly whitening the trees, but we have seen no bad results from it. If necessary it can be checked with any of the fungicides, as being wholly a surface growth it is easily killed.

BLACK KNOT.

Othia morbosus, (Schweinitz).

This well known fungus has not, as far as we are aware, caused any damage to the orchards of the state, but as it is a native, being common in the eastern part of the state on the choke cherry, *Prunus Virginiana* var. *demissa* (Nuttall), attention is called to it here. It can easily be distinguished by the coal black warts on the branches, often a foot long, which it causes. Of cultivated trees it attacks both the plum and the cherry.

An ounce of prevention is worth several pounds of cure, and a little work spent each year in cutting out and burning the knots on the choke cherry will prevent our orchards from ever being attacked by this disease.

When one reflects that each "knot" produces millions of spores, which are wafted about in the slightest breeze, the necessity of destroying them is evident.

New York state now has a law compelling every land owner to cut out and burn every year all black knots on his land, whether on wild or cultivated trees. The necessity for such a law does not exist here, and with a little care never will.

STRAWBERRY LEAF BLIGHT.

Sphærëlla fragariæ, Saccardo.

This disease is also known as leaf spot, sun burn and rust. The presence of the fungus is first disclosed by the appearance of brick-red spots on the leaves, surrounded by a darker border. The spots gradually enlarge, and the central portion becomes dead white in color. When the spots are numerous, they frequently merge into each other.

This disease is native to the state, being found abundantly on our wild strawberries; but the ordinary source of infection is through diseased nursery stock. When the disease is severe, nearly all the leaves are covered with the spots and the vitality of the plants becomes seriously impaired.

The disease thrives much more in wet or poorly drained land.

The disease can be largely prevented by three or four sprayings of Bordeaux mixture or ammoniacal solution of copper carbonate. The first spraying should be given just after harvest, followed by the others at intervals of two weeks.

A cheaper and perhaps better method for this state, especially as the disease is not very destructive, is as follows: Immediately after harvest mow the leaves close to the ground and as soon as dry burn, previously scattering straw over the field if the leaves are not thick enough to carry the fire. This will result in no injury to the plants, which at once set up a new growth of leaves, while the disease is almost wholly destroyed.

This same treatment also destroys the strawberry leaf roller, *phoxopteris comptana*, which does more injury to the strawberry in this state than any other insect.

DODDER.

Cuscuta arvensis, (Beyrich).

In some few cases, plants much higher in the scale of nature than the fungi are parasitic in habit and cause serious injury to their hosts. Of this nature are the species of *cuscuta*, or dodder, near relatives of the common morning glory, although they are commonly spoken of as weeds. Dodders, like most parasitic plants, are almost destitute of green coloring matter, *chlorophyll*, upon which the power of plants to change inorganic substances into veg-



FIG. 1.—(a) Stem of alfalfa bearing the twining stem of *cuscuta epithymum* with its clusters of flowers; (b) a single flower; (c) a mature seed; (d) the embryo; (e) ovary; (f) a stamin with its scale.

etable tissue depends, and are, therefore, entirely dependent on the juices of their host plants for existence.

The accompanying cut (Fig. 1), well represents the appearance of dodder. The stems are orange yellow in color and the flowers white.

Last spring we received from Mr. R. M. Horner, Waitsburg, specimens of a dodder (which proves to be *C. arvensis*) with the statement that it was injuring his alfalfa and asking for remedies.

We advised Mr. Horner to sprinkle the dodder with a solution of iron sulphate (green vitriol) as recommended by Beal.

The result of the experiment and answers to further questions is contained in the following letter:

WAITSBURG, WASH., September 4, 1893.

Prof. C. V. Piper, Pullman, Wash.:

DEAR SIR—I mail you to-day specimens of the dodder on alfalfa. I tried sulphate of iron, $\frac{1}{2}$ pound to one gallon of water, and also one pound to one gallon, but with no success. The branches of dodder were killed but soon threw out new ones. The chemical did not injure the alfalfa.

1. In answer to your question, I did not notice the field last year, but what I sowed this year is badly affected.

2. I have heard of but one neighbor whose alfalfa is affected.

3. I bought seed both last year and this from a Walla Walla seedsman. I have since been told that he keeps two grades of alfalfa seed, the first being clean, but he never intimated such a thing to me.

4. I think about 10 per cent. of my crop is affected.

Yours truly, R. M. HORNER.

From the above it would appear that the sulphate of iron is of little use. A solution of calcium sulphite in water is said to be used in Europe to kill the dodder with perfect success.

Better, however, than any remedies are methods of prevention. The simplest of these would be a rotation of crops; for instance, planting wheat or oats where the affected alfalfa was the year before. This dodder can only live on alfalfa or closely related plants like the clovers. If after the germination of the seed the young dodder plant cannot twine about alfalfa or clover, it must perish for lack of nourishment, and consequently the field will be freed from the pest. Care should likewise be taken to plant only clean alfalfa seed. If doubt exists as to the seed being clean, send a sample to this station for examination. As the alfalfa seed is con-

siderably larger than that of the dodder, the two can be separated by a sieve of the proper size.

Besides the above, there are three other species of dodder native to the state. None of these however live on leguminous plants, and judging from their hosts are not likely to trouble cultivated crops.

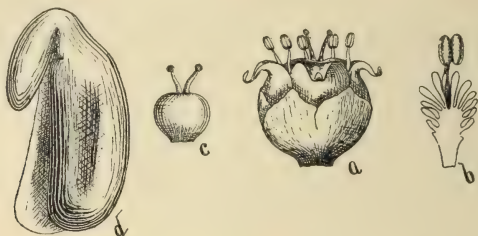


FIG. 2.—(a) Flower of *cuscuta arvensis*; (b) a stamin with its scale; (c) ovary; (d) embryo of alfalfa.

Figure 2 shows the characters of the flowers of *cuscuta arvensis* sufficiently well to distinguish it from other species.

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May 11, 1894

STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 9.

DEPARTMENT OF CHEMISTRY.

SUGAR BEETS.

BY ELTON FULMER, A. M.

All Bulletins of this Station are sent free to residents of the State.
Persons desiring their names on our mailing list should address,

PRESIDENT AGRICULTURAL COLLEGE,
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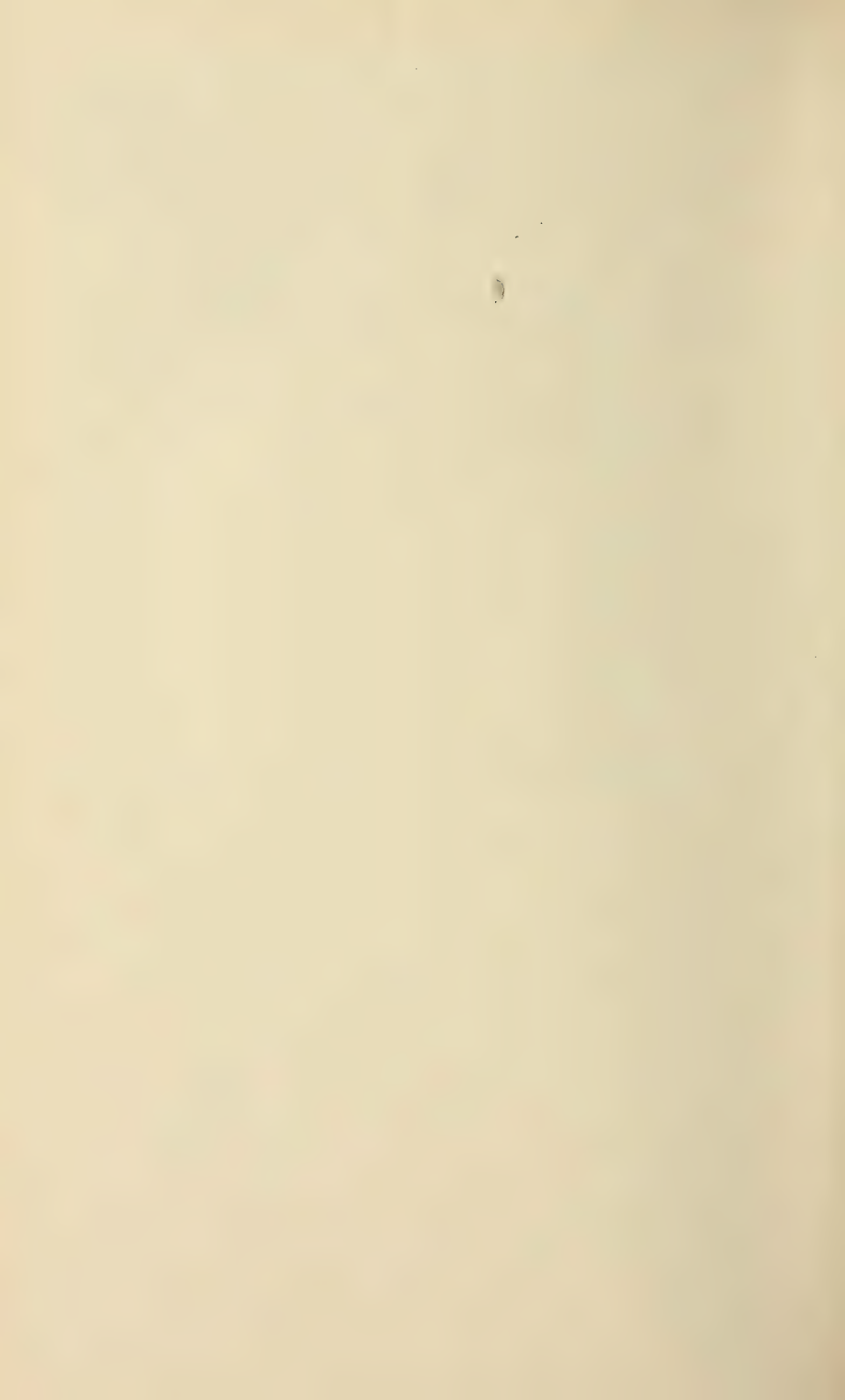
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PREFACE.

This bulletin is not put forth as the results of purely original investigation. Many of the facts concerning the general history of the sugar beet industry in Europe and in the United States were obtained from Bulletin 27, Chemical Division of the United States Department of Agriculture. Several other sources have contributed facts and statistics. Much, also, contained in this bulletin has been derived from my own experience in and observation of the industry. The only object of the bulletin is to put those engaged in agriculture in Washington in possession of facts and statistics concerning the sugar beet industry, with the hope that they may be stimulated to coöperate with the experiment station in working out the problem for Washington.

ELTON FULMER.

SUGAR BEETS.

BY ELTON FULMER, A. M.

During the last five years the question of sugar beet culture and the manufacture of beet sugar has received more or less attention from scientists, farmers, manufacturers and capitalists, in many portions of the United States. These problems have excited a very wide spread interest, and much energy has been directed toward their solution. Unfortunately, or perhaps fortunately, these problems are, to a certain extent, local in character. No one solution will answer for all conditions of soil, climate and cultivation. A large number of the states have carried on investigations in field and laboratory to determine whether or not sugar beets could be raised, sufficiently rich in sugar, and great in yield, to warrant the establishment of beet sugar factories. In some cases these investigations have been too local, spasmodic and incomplete to be of any real value. In other cases the results have seemed to prove that climatic conditions and peculiarities of soil would forever preclude the possibility of establishing a successful beet sugar industry. In still other cases it has been found that all the conditions are favorable to sugar beet culture.

Negative knowledge is sometimes of even more value than positive knowledge. It is equally important for those interested in agriculture in any state to know that sugar beets *cannot* be successfully raised, as it is for them to know the positive side of the question.

No one attempts to dispute or question the incalculable benefits that will accrue if many of our states can become producers of sugar. As regards our own state, we know that the climatic conditions render impossible the successful culture of sugar cane. We do *not* know what effect our conditions of soil, climate and moisture will have on the culture of sugar beets. No one can fail to see, however, the importance of demonstrating in a practical way what these conditions will do toward the culture of beets *for the*

manufacture of sugar; for it is a stern fact that we may be able to grow beets that are of best quality for cattle food, but *positively of no value for the manufacture of sugar*.

The success of the entire beet sugar industry depends upon the production of superior beets; and the best beets are those which give at the same time the best *yield* and are of the best *quality*. Authorities agree that no one variety of seed can possibly be suited to all conditions of soil and climate, or to all kinds of cultivation and fertilization. No more is it to be expected that every portion of our state is adapted to sugar beet culture. The sets of conditions vary so much in different portions. One set of conditions may be just right and another set entirely wrong.

It is but natural to ask, if the conditions as we find them are not suitable, may we not change them? *It may be possible*. The climate we must take as we find it. We cannot control the changes in temperature. We may supply a deficiency in moisture, and it is possible to modify the soil conditions. But in order to make these modifications a large amount of experimental and analytical work must be performed.

It is with the view of answering some of these questions, and helping to solve these problems, that the Washington Agricultural Experiment Station is preparing a sugar beet campaign for the coming season. We believe that the best and only way to determine whether any given portion of the state is adapted to raising beets *for sugar*, is to plant seed in that portion, take the right kind of care of the plant from its germination to maturity, and then determine the character of the resulting beet, not by guess work, but by *actual analysis*.

The beet sugar industry, although old in Europe, is still in its infancy in the United States. So much has been written of late concerning it that one is hardly excusable for ignorance of its history and present status. However, a brief sketch of its early history and subsequent checkered career may not be entirely devoid of interest, or out of place.

HISTORY IN EUROPE.

In 1747, Margraff, a member of the Berlin Academy of Sciences, succeeded in obtaining crystallizable sugar from beets. But imperfect methods of extraction, and the prevailing low price of sugar, made it impossible to manufacture it profitably from beets.

Half a century passed by before anything more of importance was done. Then, Achard, who was one of Margraff's pupils, took up the matter in France, in 1797. His results in extracting sugar from beets greatly astonished the people, and the papers of that time abounded in caricature and ridicule. But Achard worked on and succeeded in arousing public interest, not only in France, but also in Germany. In a very short time many workers in both countries were meeting with some success in their efforts to improve the method of extraction. The matter continued to receive the attention of the people, and finally royalty became interested. In 1811 Napoleon issued a decree in which a commission, which had been previously appointed, was authorized to establish six experimental schools for giving instruction in the manufacture of beet root sugar. In 1812 a second decree provided for the creation of four imperial beet sugar factories. The French minister of the interior, in his report upon the condition of the empire at the beginning of 1813, stated that during the year past, 7,700,000 pounds of beet sugar had been made, being the output of 334 factories; and that the average cost of manufacture was about 15 cents per pound.

During this time the industry had also assumed commanding proportions in Germany; but the war with Russia which soon followed, completely crushed it, and it was not revived again until after 1835.

The history of the beet sugar industry in Europe, taken in detail, illustrates in a very striking way how chemical skill may overcome, as it were, the perversities of climate in order to establish a national industry upon a firm basis.

From 1835 to the present time there has been a steady increase in the number of factories, and in the acreage devoted to beet culture. The conditions have so changed that now beet sugar is subject to an internal tax, instead of receiving, as at first, a bounty from the government. There are now about 2,500 beet sugar factories in Europe, and an area of 3,000,000 acres devoted to beet culture. About 30,000,000 tons of beets are produced annually, which yield about 3,600,000 tons of sugar. From the small beginnings made by Achard in 1797, the industry has grown on European soil to amazing proportions. The sugar production for the season of 1891-92 was as follows: Germany, 1,280,000 tons; Austria, 850,000; France, 750,000; Russia, 530,000; Belgium, 296,000; Holland, 50,000; *total, 3,756,000 tons.*

HISTORY IN THE UNITED STATES.

Although the beet sugar industry has been such a profitable one for so many years in France, Germany, Austria and Russia; while with them it has been carried to such astonishing lengths, we have stood idly by, an importer and consumer instead of producer; failing to profit by European knowledge and experience. It is true that at a comparatively early date, as well as at later times, attempts were made to establish the enterprise in America. Unfortunately, in nearly every case, conclusions were based on insufficient evidence, and steps taken without first counting the cost.

As early as 1830, experiments were inaugurated in Pennsylvania by two men who seem to have been entirely ignorant of the essential requirements of success, and who, very naturally, met with complete failure.

In 1838, the second attempt to manufacture beet sugar on a commercial scale, in America, was made by David Lee Child, at Northampton, Mass. Mr. Child had previously visited Europe to study the subject of sugar production, and hence had some knowledge of it. But he was unable to obtain the working details of the recently invented method of drying the roots, then in use in Germany, and was obliged to use a method of his own, which was not entirely satisfactory. Only about 1,300 pounds of sugar were made at this plant. It is stated that the cost of culture in the Connecticut river valley was \$42 per acre; the average yield from 13 to 15 tons per acre; the cost of making sugar 11 cents per pound; and that the beets yielded 6 per cent. of sugar and $2\frac{1}{2}$ per cent. of molasses.

Nothing more of importance was done in connection with this industry until 1863, when works were established at Chatsworth, Illinois, by the Gennert Brothers. But here, a combination of bad management, ignorance of the business, improper culture, excessive rain during one season, and prolonged drouth during another, together with wrong conditions of soil and climate, brought about almost total failure after nearly six years of discouraging work. With the hope of better things, the plant was finally moved to Freeport, in the same state. No better results followed. It could not be otherwise inasmuch as the two prime factors of success—a proper soil and climate—were lacking. Part of this machinery was finally moved to Black Hawk, Wisconsin, but the enterprise was doomed to failure there, as elsewhere.

The first really good results were obtained at Fond du Lac, Wis-

consin, by Messrs. Bonesteel and Otto. But their means were limited, and when they received an offer of the management of the Alvarado Sugar Co., in California, they accepted it. Although this company had a capital of \$250,000, an unsuccessful struggle of several years finally resulted in financial failure, and operations were suspended in 1876. Several other companies were organized in California between 1870–80, but all met with failure. Factories were also established in Maine and Delaware, but these met with the universal fate. The Alvarado company was finally reorganized in 1879, and has been in successful operation from the very start.

Six factories are now operating successfully in the United States; at Alvarado, Chino and Watsonville, in California; at Lehi City, in Utah; and at Grand Island and Norfolk, in Nebraska.

HISTORY IN NEBRASKA.

In 1868 Dr. Thorpecher, who, as a native of Germany, had some knowledge of the beet sugar industry, obtained some seed from Washington, D. C. A single trial was sufficient to show that sugar beets would grow well in Nebraska. Analysis also showed that the beets raised that year contained from 8 to 10 per cent. of sugar when grown on high land, and from 12 to 15 per cent. when grown in the Platte river valley. A few years later several parties became interested in the matter and proposed the erection of a factory. Some time before this there had been a complete failure in Canada, and it was found that the machinery could be purchased for \$25,000—less than one-eighth of its original cost. Preparations were made to transfer this machinery to a certain point in Hall county. Just about this time it was learned that the import duty from Canada would be \$75,500. Upon learning this fact the enterprise was abandoned.

During 1888 a considerable amount of seed was planted in different portions of the state, and the beets grown from it gave very satisfactory results, yielding a sugar content of 12 to 18 per cent.

In the spring of 1889, the chemical department of the state experiment station (with which the writer at that time was connected), began a series of investigations similar to those now proposed for this state, the object being to ascertain if the soil, climate and other conditions were such as would make the state adapted to sugar beet culture. These investigations were carried on with great care, and extended into all parts of the state. The results proved conclu-

sively that Nebraska soil could produce beets sufficiently rich in sugar to be used in its manufacture.

Meanwhile, parties in Hall county had not been idle; and it was finally decided that a factory should be erected at Grand Island. After a great many efforts a contract was at last closed between the Grand Island Improvement Company and Mr. H. T. Oxnard. Before this contract was closed, however, the state legislature had provided for a bounty of one cent per pound on all sugar manufactured in the state from beets grown in the state—all of the bounty going to the manufacturer and none to the beet grower.

The conditions of the contract were as follows: The Improvement Company agreed to donate forty acres of land near the city of Grand Island for a factory site; to pay all taxes for the years 1891-92; to furnish 5,000 acres of land for raising beets, at a price of not to exceed \$15 for unimproved, and not over \$25 per acre for improved land; and lastly, to guarantee the growing of 3,000 acres of beets for three years. Mr. Oxnard agreed to pay \$3 per ton for beets containing 12 per cent. of sugar, and 25 cents more per ton for each additional per cent. of sugar. The contract was signed December, 5, 1889, and work was begun at once. The factory was ready to begin work in the fall of 1890.

SUGAR OUTPUT IN NEBRASKA.

The Grand Island factory has now finished its fourth campaign, its total output of sugar being 6,009,800 lbs., produced as follows:

	<i>Pounds.</i>
1890.....	756,300
1891.....	1,318,600
1892.....	2,101,000
1893.....	1,833,900

These figures show that the amount of sugar produced annually has steadily increased until last year, when there was a decrease of 245,100 pounds, owing to the failure of the farmers to raise as many beets as were desired. It is a strange fact that in spite of the profits reaped by the few who have made beet raising a prominent feature of their farming, and who have performed the work *necessary* to produce beets *for sugar*, the majority of those engaged in farming look upon the industry with disfavor and suspicion. Notwithstanding the statistics showing the profits of beet raising, the farmers of Nebraska have been slow in deciding to take up sugar beet culture. This was perhaps the worst difficulty the manufacturers encountered; but they were equal to the occasion, and

began raising beets themselves. Last year they had 1,185 acres in beets. In attempting to explain why most of the farmers assumed such an attitude to the industry it must be remembered that it was something new, and also that the bounty offered by the state was all for the manufacturer. Hence, it was only natural that feelings of jealousy should spring up and prevent coöperation between the farmer and manufacturer. Had the bounty offered there been divided as it is in Washington, one-half going to the beet grower and one-half to the manufacturer, much of the above mentioned difficulty would not have existed. However, a turning point seems to have been reached now, and hearty coöperation will doubtless be soon realized.

The factory at Norfolk was built in 1891, and has been very successful from the beginning. The output for last year was between 5,000,000 and 6,000,000 pounds of sugar.

PRICES PAID FOR BEETS.

In 1890 and 1891 the following prices were paid for beets: For those containing 12 per cent. of sugar and having a *purity coefficient of 80, \$3 per ton; for those containing 13 per cent. of sugar and same purity coefficient, \$3.25; and 25 cents more per ton for each additional per cent. of sugar, the coefficient of purity remaining the same. In 1892 \$4 per ton was paid for beets containing 12, 13 and 14 per cent. of sugar, and having a purity coefficient of 80; and 50 cents more per ton for each additional per cent. of sugar and same purity coefficient. In 1893 the company paid \$5 per ton straight, regardless of sugar content.

HISTORY IN WASHINGTON.

For some years past sugar beets have been raised in various sections of the state which, we are told, contained a high percentage of sugar.

In a letter written by Mr. E. Meeker, of Puyallup, Washington, and published in Bulletin 27, Division of Chemistry, U. S. Department of Agriculture, it is stated with reference to Western Washington, that the beets raised there in 1890 were rich in sugar, and unusually pure. Sixty-five (65) tons are said to have been raised on two acres of land, at a cost of \$2.25 per ton, or \$73.12 per acre. Had these beets been sold at \$5 per ton, there would have been a net profit of \$89.38 per acre. This same letter also

*The coefficient of purity is the ratio of sugar to the other solids in the juice of the beet. For example, if in 100 parts of the solids in the juice there are 80 parts of sugar the coefficient of purity is said to be 80.

states that Mr. T. M. Alvord, of White River, had raised 100 tons of beets per year, for five years, at a cost of \$2.50 per ton, the yield being 20 tons per acre. Nothing is said, however, about the sugar content and purity as shown by actual analysis. It is also stated that none of the land of Eastern Washington is suited to sugar beet culture, because of an excess of alkali in the soil. This statement, however, does not seem to be supported by the facts in the case.

Bulletin 33, of the Division of Chemistry, states that in 1891, eleven samples of beets from Washington were received for analysis at Washington, D. C. These eleven samples represented six counties, as follows: Lewis, 3; Snohomish, 1; Spokane, 1; Stevens, 2; Whatcom, 2; Whitman, 2. The average sugar content was found to be 14.47 per cent., and the average coefficient of purity, 83.9.

Bulletin 36, also of Division of Chemistry, shows that in 1892, fourteen samples were analyzed from our state, the samples coming from four counties as follows: Douglas, 2; Spokane, 5; Stevens, 2; Whitman, 5. With reference to these samples, it is reported as follows: Average percentage of sugar, 14.52; average purity coefficient, 76.8; average yield per acre, 14.32 tons; average weight of beets, 18 ounces.

Through the courtesy of Hon. John R. Reavis, of Spokane, we are able to state the results obtained from beets sent to Washington, D. C., in December, 1893. These beets were grown by Mr. E. H. Morrison, of Fairfield, and represent four different varieties of beets. The results are as follows:

No.	Variety of beet.	Average weight of beet.	Per cent. sugar in juice.	Coefficient of purity.
1...	Klein Wanzlebener.....	8.02	18.7	84.9
2...	Klein Wanzlebener.....		14.9	77.9
3...	Klein Wanzlebener.....	11.5	15.5	79.5
4...	Klein Wanzlebener.....	22.25	13.9	77.7
5...	Vilmorin's Richest.....	20.25	14.0	76.9
6...	Vilmorin's Richest.....		15.0	80.7
7...	Knauer's Imperial.....		15.3	78.1
8...	Florimond Desprez.....	18.25	16.8	86.2
9...	Florimond Desprez.....	17.25	13.8	78.8
10...	Vilmorin Ameliorée.....	6.75	17.1	85.0
11...	Vilmorin Ameliorée.....	6.25	16.4	85.4

These results give an average sugar content of 14.8 per cent., and average purity, 81.

These are all the reliable statistics that could be obtained regarding what has already been done with beet culture in Washington. None can deny but that the results thus far obtained are most encouraging. They are good as far as they go, but do not go far enough.

DOES BEET RAISING PAY?

It is self evident that a farmer should not raise crops that do not pay. Whether beet raising will be a good paying enterprise in Washington can only be determined by trial. Reports from Watsonville, California, show that for 1891 the average yield per acre for beets was between 13 and 14 tons, and the average price paid \$5 per ton. The cost of production, not including rent of land, was from \$26 to \$40 per acre. It was considered that the average *net profit per acre* was not less than \$30. Statistics from Alvarado for the same year show the average yield to have been 15 tons per acre, and the average price paid per ton, \$5. The cost of production was estimated at \$46 per acre, thus leaving a *net profit per acre* of \$29. The average yield in Utah for the same year was 12 tons per acre, and the price paid, \$5 per ton. After deducting the cost of production, the *average net profit* was \$20.54 per acre. The history of sugar beet culture in Nebraska during the past three years shows that the average yield per acre for the entire state is about 15 tons; the average sugar content 13.5 per cent., and the cost of production varying from \$14.75 to \$22.85 per acre. The Standard Cattle Company, of Schuyler, Nebraska, furnished the Norfolk factory last year with the beets from 500 acres, the average yield being 17 tons per acre. This crop is said to have netted the growers \$60 per acre.

These statistics speak for themselves. It is well known that under the most favorable conditions, none of the crops ordinarily raised on the farm can be made to yield as much net profit per acre as does the sugar beet when properly treated. It has also been a noticeable fact that in seasons of drouth, when wheat, corn and oats were failures, the beet crop was a great success.

WHAT CAN BE DONE IN WASHINGTON.

Before a sugar factory will ever be located on Washington soil two important points must be determined: First, if our soil and climate are well adapted to the growth of sugar beets, can the

farmer raise them in such quantities that they can sell them (with a fair profit to themselves) to the manufacturers at a price they can afford to pay and still make a reasonable profit in manufacturing sugar? If the farmers lose money in raising beets for supplying the factory, the enterprise will necessarily fail. This question must be settled by the farmers themselves. Experience in other states shows that it can be done in some places. Can it be done in Washington?

The second point is, will the beets raised in Washington be sufficiently rich in sugar to be used in its manufacture?

These points must not be settled by guess work. In view of the repeated failures of the past, capital is very cautious about taking hold of beet sugar enterprises. Capital can never be induced to establish a plant in Washington until there has been a more complete demonstration of the adaptability of soil and climate to sugar beet culture. It is very true that many beets have been raised in the state containing a large percentage of sugar, and having a high degree of purity; but other points must be considered and much more experimentation in the same line be carried on before a factory will be among the possible things.

It is of great importance to all engaged in agriculture in Washington to have the above mentioned points settled with reference to each locality in the state.

The agricultural experiment stations exist for the purpose of giving aid and coöperating with the farmers in matters of this kind. The laboratory of the Washington station is well equipped for doing any work connected with the analysis of sugar beets or their products, and the chemical department is ready to give any aid possible. In a word, it is our earnest desire to form a partnership with all the farmers in the state who are interested in this matter, the basis of partnership to be as follows: We agree to furnish seed and printed directions for the culture of the beet; we further agree to pay transportation charges on all beets sent to the department for analysis, and to make the analyses *free of cost*; to preserve and correllate the data thus obtained; to print the same in a bulletin, a copy of which will be sent free to all farmers.

We ask the farmers on their part, to measure off a definite portion of land, about 10 to 20 feet square, in which the seed will be planted at such time and in such manner as we shall indicate, *as nearly as possible*; to properly cultivate and otherwise care for the

beets during their period of growth, according to directions furnished, *as nearly as possible*; when the beets have reached maturity to select samples for analysis at such time and in such manner as we may prescribe, *as nearly as possible*; to send said samples to us; to keep an accurate record of the kind of seed, time of planting, size of plat, quality of soil, kind and amount of cultivation, etc.; also, to carefully estimate the yield and cost of production per acre; and lastly, to furnish us with these and all other data bearing on the subject, for publication.

Now, is not this a fair proposition? It will cost the farmer nothing but a little time and labor. We would be glad to have 500 men coöperate with us in this matter.

Farmers of Washington, the question is before you; *what will you do with it?* If you are willing to take hold with us in this work for the advancement of agriculture in Washington, please send us your name and address not later than March 10, 1894. Seed will be distributed about March 20th.

In the meantime we shall be glad to answer any questions concerning this or any other subject pertaining to the agricultural interests of the state. Write us fully and freely. We will take great pleasure in replying.

To all interested in agriculture, let me say: Let us heartily coöperate in this matter. Let us make this sugar beet campaign so successful that the results obtained may be more reliable and conclusive because they are based on the experiences of a large number of workers.

Address, ELTON FULMER,
*Chemist, Experiment Station,
Pullman, Washington.*

There is an additional inducement for the farmers of Washington to raise beets, because of the provisions of section 2, chapter 68 of the state session laws for 1893. Section 2 reads as follows:

“Any persons, firm or corporation shall receive from the state treasury the sum of one-half ($\frac{1}{2}$) cent for each and every pound of sugar manufactured within the State of Washington from sugar yielding plants grown within said state by such persons, firm or corporation.”

The manufacturer is provided for in section 1, which reads as follows:

“Any persons, firm or corporation shall receive from the state treasury the sum of one-half ($\frac{1}{2}$) cent for each and every pound of sugar manufac-

tured within the State of Washington, by such persons, firm or corporation, from sugar producing plants grown within the state."

Section 7 reads:

"The benefits of this act shall accrue to any persons, firm or corporation, and to all persons furnishing them sugar producing plants, that shall commence the erection of a sugar manufactory within two years from the passage of this act, and shall have completed the same ready for operation by the first day of July, 1896; and the bounty herein provided for shall be paid to said persons, firms or corporations for the period of five (5) years from the completion of the said manufactory. This act shall be taken and considered to be a contract and irrevocable with all such persons, firms or corporations as shall commence and complete the erection of such manufactory within the time hereinbefore specified, and with all persons, firms or corporations furnishing them sugar growing plants as herein provided."

The above act was approved March 9, 1893.

By the provisions of this act the beet grower and the sugar manufacturer share alike in the bounty offered by the state to encourage this industry.





May 11, 1894

STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 10.

AGRICULTURAL NOTES.

WHEATS, BARLEYS, OATS, PEAS AND FORAGE CROPS.

Review of Weather and Crops in Washington for 1893.

DECEMBER, 1893.

OLYMPIA, WASH.:

O. C. WHITE, STATE PRINTER.

1894.

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AGRICULTURAL NOTES.

WHEATS, BARLEYS, OATS, PEAS AND FORAGE CROPS.

E. R. LAKE.

The plats of small grains, with one exception, were grown on the ridge to the north of the college barn, the object being to give to each plat proportionate advantages and disadvantages of north and south slope and ridge-top. In round numbers the plats were from two to six rods wide and ten to thirty rods long, and varying in area from thirty-six to two hundred and twenty square rods, the average area being one hundred and nine square rods.

Plat 1 did not embrace the north slope, which is a favorable slope for grain crops in this section, while plats seven to sixteen were favored with a longer and gentler south slope of more fertile soil than the south slopes of other plats. Plat 17 was located just west of the farm house in a slight depression and on both sides of the drive. In general, the soil of the south half of plats one to ten is below the average of the farm in fertility. The whole ridge has been cultivated for years, and each time in plowing the soil has been turned down hill on either slope until the top of the ridge is scarcely more than raw clay.

Owing to the incomplete organization of this department during the first six months of this year only the crudest of notes have been taken on all plat work on the farm. The relative yields, which have been computed with as much care and accuracy as the circumstances would permit, are perhaps the only points of interest or value to the farmer. Plats one to ten, inclusive, were sown April 29th, others May 1st.

WHEATS.

PLAT 4—*Saskatchewan Fife*.—One hundred and twenty pounds of seed sown, three inches deep, on two hundred and twenty square rods. Yield, two thousand pounds; practically, twenty-five bushels per acre.

PLAT 5—*Blue Stem*.—One hundred and four pounds of seed sown, three inches deep, on one hundred and ninety-eight square rods. Yield,

one thousand five hundred and fifty pounds; practically, twenty-one bushels per acre.

PLAT 6—*Wellman Fife*.—Forty-five pounds of seed sown, two inches deep, on eighty-one square rods. Yield, five hundred and eighty-two and one-half pounds; practically, nineteen and one-fifth bushels per acre.

PLAT 7—*White Russian*.—Fifty-two pounds of seed sown, one and one-half inches deep, on eighty-seven square rods. Yield, eight hundred and seventy pounds; practically, twenty-six and two-thirds bushels per acre.

PLAT 8—*Velvet-Chaff Blue Stem*.—Forty-five pounds of seed sown, three inches deep, on eighty-six square rods. Yield, eight hundred and seventeen and one-half pounds; practically, twenty-five and one-third bushels per acre.

PLAT 9—*Velvet-Chaff*.—Forty-six pounds of seed sown, two inches deep, on seventy-eight and one-half square rods. Yield, eight hundred pounds; practically, twenty-seven and one-sixth bushels per acre.

BARLEY.

PLAT 1—*Manshury*.—Forty-two pounds of seed sown, four inches deep, on sixty square rods. Yield, four hundred and fifty-two and one-half pounds; practically, twenty-six and three-eighths bushels per acre.

PLAT 2—*Highland Chief*.—Twenty-three pounds of seed sown, two inches deep, on thirty-six square rods. Yield, three hundred and twenty-seven and one-half pounds; practically, thirty and one-third bushels per acre.

PLAT 3—*Nepaul (Hulless)*.—Fifty-seven pounds of seed sown, three inches deep, on sixty-six square rods. Yield, six hundred and sixty pounds; practically, thirty-three and one-third bushels per acre.

PLAT 10—*Highland Chief*.—One hundred and eight pounds seed sown, one and one-half inches deep, on seventy-eight and one-half square rods. Yield, one thousand seven hundred and sixty pounds; practically, seventy-four and seven-tenths bushels per acre.

PLAT 11—*Black*.—Eighty-five pounds of seed sown, two inches deep, on seventy-one and two-thirds rods. Yield, six hundred and forty pounds; practically, twenty-nine and three-fourths bushels per acre.

OATS.

PLAT 12—*American Banner*.—Eighty-three pounds of seed sown, two inches deep, on one hundred and five square rods. Yield, eight hundred and forty-five pounds; practically, forty-four bushels per acre.

PLAT 13—*White Russian*.—Ninety-six pounds of seed sown, four inches deep, on one hundred and five square rods. Yield, seven hundred and thirty-seven and one-half pounds; practically, thirty-five bushels per acre.

PLAT 14—*Golden Giant*.—Ninety-six pounds of seed sown, three inches deep, on one hundred and sixty-five square rods. Yield, one thousand seven hundred and fifty pounds; practically, fifty-three bushels per acre.

PLAT 15—*Race Horse*.—Ninety-four pounds of seed sown, two inches deep, on one hundred and five square rods. Yield, one thousand nine hundred and thirty-two and one-half pounds; practically, ninety-two bushels per acre.

PLAT 16—*White Bonanza*.—One hundred pounds of seed sown, three inches deep, on one hundred and fifty square rods. Yield, one thousand one hundred and forty pounds; practically, thirty-eight bushels per acre.

PLAT 17—*White Bonanza*.—Sixty-four pounds seed sown, one inch deep, on one hundred and sixty square rods. Yield, nine hundred pounds; practically, twenty-eight bushels per acre.

FORAGE CROPS.

PLAT 19*—*Alsike Clover*.—Sown in spring of 1892. Yielded, of thoroughly dried hay, one hundred pounds. Cut June 29th. Area, thirty-nine and one-third square rods; practically, four hundred pounds per acre.

PLAT 20—*Orchard Grass*.—Sown in spring of 1892. Yielded, of thoroughly dried hay, three hundred pounds. Cut June 29th. Area, twenty-six and one-fourth square rods; practically, one thousand eight hundred and thirty pounds per acre.

PLAT 21—*Out Grass*.—Sown in spring of 1892. Yielded, of thoroughly dried hay, eight hundred pounds. Cut June 30th. Area, forty-six and one-half square rods; practically, two thousand seven hundred and fifty pounds per acre.

PEAS.†

This crop was sown in single drills seventy-five feet long. The merits of home grown and seed kept two years as compared with foreign grown and one-year-old seed as to per cent. of weeviled fruit, are not such as to be readily formulated into a general statement, though on the whole there seems to be a less percentage of weevil in the crop from home grown seed. Data as to earliness and productiveness must necessarily cover several years.

All that it is expected to answer in this varietal test at present is the relative productiveness and quality of the leading commercial varieties as offered by the seedsmen.

PLAT 1—*Alaska*.—A dwarf-growing early pea, having a small pod. Peas, small, round, smooth, and of pale green color. Yield, twelve pounds. Ripens about July 15th. Weeviled, 23 per cent. Henderson, 1892.

PLAT 2—*Alaska*.—Same as the above in all material respects except

* Plat 19 produced considerable wheat together with the Alsike, the result of volunteer seeding.

† Data for these notes on peas were gathered and compiled by L. C. Read, assistant to the Horticulturist.

yield was much less, owing to the greater effect of drouth, and weeviled only 9 per cent. Home grown, 1892.

PLAT 3—*American Wonder*.—A dwarf-growing, very early pea having a small pod. Peas, medium, flat, wrinkled. Yield, eight and one-quarter pounds. Ripens about July 1st. Weeviled about 13 per cent. Excellent flavor. Henderson, 1892.

PLAT 4—*American Wonder*.—Same as above except affected by drought. Yield, five and one-quarter pounds. Weeviled, 5 per cent. Home grown, 1892.

PLAT 5—*Bliss Everbearing*.—Medium growth of vine, small pod, although the pea is very large, flat and wrinkled, of pale green color. Yield, six pounds. Ripens about August 1st, and is of excellent flavor, and a fine pea generally. Weeviled, 5 per cent. Home grown, 1892.

PLAT 6—*Blue Imperial*.—Medium growth of vine, with small pods. The pea is flat, smooth, average, and of a bluish tinge, hence its name. Yield, nine pounds, ripened fruit about July 15th. Weeviled, 19 per cent. Henderson, 1892.

PLAT 7—*Blue Beauty*.—This is a fairly early pea, but of quite poor flavor. The pod small, pea medium size, round, smooth, and of pale green or bluish color, ripens about July 1st. Yield, five pounds. Weeviled, 19 per cent. Henderson, 1892.

PLAT 8—*Blackeyed Marrowfat*.—This variety made large growth of vine, large pods, with rather large, smooth cream colored pea. Ripens August 1st. Yield, ten pounds. Weeviled, 5 per cent. Henderson, 1892.

PLAT 9—*Chelsea*.—A dwarf-growing early variety. Ripens early in July. The pea is medium sized, wrinkled, and of pale green and cream color. Yield, nine and three-quarter pounds. Weeviled, 20 per cent. Henderson, 1892.

PLAT 10—*Dwarf Sugar*.—An early dwarf variety, with edible pods. Ripens in July. Has small pods, with small, round, smooth pea, of cream color when ripe. Yield, ten pounds. Weeviled, 10 per cent. Home grown, 1892.

PLAT 11—*The Don*.—This variety made a heavy growth of vine, with large pods, but not very well filled. The pea is large, flat and wrinkled, of a pale green and cream color. Ripens August 1st. Yield, five pounds. Weeviled, 16 per cent. Henderson, 1892.

PLAT 12—*Evolution*.—This variety is one of large growth; large pod, well filled. Pea large and even in size, smooth and flat in shape, of deep green color. Ripens August 1st. Yield, eleven pounds. Weeviled, 20 per cent. Henderson, 1892.

PLAT 13—*Gladiator*.—This variety made a heavy growth of vine, with large, well-filled pods. It is a medium, smooth, rather angular pod of pale green color. Ripens July 15th. Yield, nine pounds. Weeviled, 12 per cent. Henderson, 1892.

PLAT 14—*Heroine*.—This variety was quite prolific. Large growth of

vine and well filled, large pods. Ripens August 1st. Pea large, flat and wrinkled, of pale green color. An excellent variety. Yield, eleven and three-quarter pounds. Weeviled, 19 per cent. Henderson, 1892.

PLAT 15—*Henderson's First of All*.—A very good early variety. Made a large growth with small, well-filled pods. The pea is of fair size, some round and smooth, others flat and wrinkled, pale green and cream color. Ripens early in July. Yield, eight pounds. Weeviled, 8 per cent. Home grown, 1892.

PLAT 16—*Henderson's Midsummer*.—A very prolific variety. Made a large growth of vine with large, well-filled pods. The pea is of very fine flavor; is large, flat and wrinkled, of pale green and cream color. Ripens August 1st. Yield, fifteen pounds. Weeviled, 22 per cent. Henderson, 1892.

PLAT 17—*Laxton's Fillbasket*.—This variety has small, fairly well filled pods. Peas round, smooth, medium and green in color. Ripens August 1st. Yield, eight and one-fourth pounds. Weeviled, 17 per cent. Home grown, 1892.

PLAT 18—*Laxton's Alpha*.—This variety made much the same growth as the Alaska. Very dwarf. Pea is of medium size, wrinkled and green in color. Ripens about July 15th. Yield, six pounds. Weeviled, 20 per cent. Home grown, 1892.

PLAT 19—*McLean's Little Gem*.—Dwarf variety, small pods well filled. Ripens July 15th. Pea medium, flat, wrinkled, and green and cream in color. Yield, nine and one-half pounds. Weeviled, 19 per cent. Henderson, 1892.

PLAT 20—*Shropshire Hero*.—This variety gave a large growth of vine, with large pod. Pea large, flat and wrinkled, pale green color. Ripens August 1st. Yield, seven and one-half pounds. Weeviled, 5 per cent. Home grown, 1892.

PLAT 21—*Stratagem*.—Large pod, not very well filled. Pea large, flat and wrinkled, green in color. Ripens August 1st. Yield, six and one-half pounds. Weeviled, 26 per cent. Henderson, 1892.

PLAT 22—*Tom Thumb*.—This variety made a vigorous growth, but produced little fruit of only ordinary quality. Pods small; pea small, round and smooth, pink color. Ripens August 1st. Yield, seven pounds. Weeviled, 15 per cent. Home grown, 1892.

PLAT 23—*Telephone*.—This variety made a large growth of vine, with large, well filled pods. In fact, it is a very profitable variety; bears a fine, large pea, wrinkled, and pale green and cream in color. Ripens in July. Yield, twelve pounds. Weeviled, 17 per cent. Home grown, 1892.

PLAT 24—*Telegraph*.—This variety made quite a large growth of vine, with large, well filled pods. Pea large, round and smooth; pale green color. Ripens July 15th. Yield, nine pounds. Weeviled, 18 per cent. Henderson, 1892.

PLAT 25—*Tom Thumb*.—This is the same variety as plat 22. This

plat, however, seemed to ripen earlier and yielded better than plat 22. Yield, ten pounds. Weeviled, 13 per cent. Home grown, 1892.

PLAT 26—*Telegraph*.—Same variety as plat 24. This one, however, was from home grown seed. Yield, eight and one-half pounds. Ripens July 15th. Weeviled, 11 per cent. Home grown, 1892.

PLAT 27—*White Marrowfat*.—This very prolific variety made heavy growth of vine, with large, well filled pods. Pea large, smooth and round; of cream color. Ripens August 1st. Yield, nineteen and one-fourth pounds. Weeviled, 9 per cent. Henderson, 1892.

PLAT 28—*White Marrowfat*.—Same variety as plat 27, and the yield was about the same. Weeviled, 6 per cent. Home grown, 1892.

PLAT 29—*Yorkshire Hero*.—A very prolific variety. The pea is large, flat and wrinkled, with light green and white color. Ripens August 1st. Yield, fifteen pounds. Weeviled, 23 per cent. Henderson, 1892.

STATE AGRICULTURAL COLLEGE AND SCHOOL OF SCIENCE

IN COÖPERATION WITH THE

WASHINGTON STATE WEATHER SERVICE, DEPARTMENT OF AGRICULTURE.

REVIEW OF THE WEATHER AND CROPS IN WASHINGTON FOR SEASON OF 1893.

In many respects the crop season of 1893 in the State of Washington has been a remarkable one. Owing to the continued rainy weather during the first three months of 1893, general farming operations which in this state usually begin in March were delayed from two to five weeks in all counties west of the Cascades and in the northeastern part of the state. At the time plowing and seeding were begun the soil was very wet, soggy and cold in all counties in the state, except in portions of the southeastern counties, where it was comparatively dry. The season opened with a March temperature of 3.4 degrees colder than average, and a rainfall which, though .08 inches less than the normal, gave a much larger number of rainy days than is usual at this time of year. This excess of moisture was more noticeable in the eastern portion of the state. April was an unfavorable month to agriculturists. Its mean temperature was no less than 4.7 degrees colder than the average; its rainfall was remarkably heavy, being 3.04 inches above the normal April values. Plowing and seeding were consequently delayed and the growth and development of the crops already in the ground greatly retarded. May was another cold, rainy month, with a mean temperature of 2.8 degrees colder than usual, and a rainfall 1.19 inches heavier than the average. The sunshine during this and the preceding months was woefully deficient. Cold rains injured orchards to some extent. June brought very little change in the weather conditions that prevailed during the preceding five months. The deficiency in the temperature was 5 degrees

greater than that of any other month of the season. The rainfall was only a little less than the average. On the whole, the season was not favorable to crops, and the injury to fruit from cold showers was increased. July, with a mean temperature of 1.8 degrees colder than the average and a rainfall of .16 of an inch less than usual, but with plenty of sunshine, brought relief to suffering vegetation, especially to fruits and vegetables, and was generally beneficial to all crops. August was in every respect the ideal month for the farmers. Its temperature and its rainfall were only slightly below the average. There was a goodly amount of sunshine, which proved of immense benefit to all crops. September was a tolerably favorable month for the farmers. Its temperature was a little below the average and its rainfall a trifle above the usual September rainfall. October was a red letter month. Its phenomenal rainfall, especially in Eastern Washington, and its low temperature were exceedingly injurious to all crops.

Summarizing the above it will be seen that the rainfall has been excessive in all sections during March, April, May, June and October, and the temperature for each month colder than usual over the entire state. The season has been almost entirely free from hot burning winds, that occasionally prevail in the eastern portion of the state during August, the only very warm spell being that from July 28 to August 5, during which the thermometer in some of the eastern counties rose to 102 degrees on several days. The injury resulting to crops from this warm weather was insignificant and altogether restricted to only a small area.

EFFECT OF WEATHER CONDITIONS.

Now, as to the effect of these conditions on the crops of 1893, owing to the lateness of spring the wheat crop, which is by far the most important grown in this state, was not planted in Eastern Washington north of the Snake river much before the latter part of May, while in Western and Southeastern Washington it was all sown by the middle of April. From this time on the history of this year's wheat is a truly extraordinary one. The heavy rain and snowfall of the winter and spring thoroughly saturated the soil with moisture, which, having been retained throughout the summer, assured a good yield despite the comparatively dry summer weather.

The weather during July and August and greater part of September was such that the grain sprouted, grew and flourished in a manner

that gladdened the heart of the Eastern Washington farmers and brought a smile of great satisfaction to the face of the merchants of this state, whose prosperity, after all, depends so much on the results of the labors of their agricultural fellow workers. As early as June predictions were freely made by old settlers, that this season's wheat crop would even exceed that of the famous blockade year of 1890, the acreage this season having been largely increased.

By the middle of September, all of this had been realized and the crop was pronounced the largest grown in this state for many years, but alas, the unfortunate farmers whose hopes hinged on the success of their one crop alone were doomed to disappointment, for, on September 28, a rainy spell the like of which had never been heard of within the memory of the oldest inhabitant set in and lasted without interruption till October 12th. The season being very late, as we have already said, thousands of acres of standing wheat in Whitman, Stevens, Lincoln, Spokane and Douglas counties were knocked down and greatly injured, while acres upon acres of grain in stack were completely ruined. The loss in these counties from this unprecedented and unusual downpour of rain has been variously estimated at from 2,000,000 to 3,000,000 bushels.

THE BARLEY CROP.

Sowing of barley was begun in nearly all sections by the middle of April, though in some counties as late as June 1. The acreage of this crop compared with that of last year shows a decided increase. This has been a very favorable season for barley, the yield having been fully up to the average. The harvesting of barley was well in hand in all counties by the end of August.

THE OAT CROP.

The greater portion of the oat crop was planted in Western Washington before May 15th and in the eastern portion of the state a little later. The oat crop this season has been a tolerably satisfactory one. The yield in most cases was fully up to the average. The acreage of this crop compared with the preceding year shows an increase. Harvesting was begun about the middle of August in Eastern Washington, and about the end of the month in Western Washington, the season being about two to four weeks late.

THE HAY CROP.

This season's hay crop was an excellent one from every standpoint, the quantity as well as the quality being up to the average

in all sections of the state where the crop is grown. The crop was housed in good condition by the end of August in Western Washington, and about fifteen days later in the eastern portion of the state.

THE FRUIT CROP.

Fruit growers interested in small berries have every reason to feel satisfied with this year's crop, which was immense in almost every county in the state. The strawberry crop was particularly abundant in Clarke county. Washington bids fair to rival the Golden State in the matter of successful fruit raising. Melons, prunes and plums were a fair crop, but cherries and apples were seriously injured by the cold showers of early spring and by the lack of sunshine following. Insects in large numbers have made their appearance in the orchards of this state this year, but so far have been kept in check by careful spraying, as recommended by the state fruit inspector. Clarke county prune raisers have made a record this season. Tons of the Italian variety were successfully dried in the different dryers in that county during the season.

THE HOP CROP.

This year's hop crop has been up to the average both in quantity and quality. Owing to the lateness of the season, picking began from one to three weeks later than last year. This was rather an advantage though, because when they were picked there was less mould and the vines better matured. In some yards tributary to the Puyallup hop growing country, this year's crops yielded almost twice as much as last year. This is attributed to the fact that last year the vines were not cut as had been the custom heretofore, but the poles were cut down to within seven feet of the ground and the vines trained on twine. This year's experience has taught our hop growers that vines trained on twine mature more solidly and weigh more than those trained in the old way. Washington hops are attracting considerable attention in Europe, and are pronounced by connoisseurs to be far superior to any grown in England. The average yield of Washington hops, too, is generally higher by 100 or 200 pounds to the acre than those raised in other parts of the world.

H. F. ALCIATORE,

Director.

May 11, 1894

WASHINGTON STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 11.

(Bulletins sent free to all farmers and others upon application to this
Station.)

Preliminary Report of a Feeding Test with Swine.

FEBRUARY, 1894.

OLYMPIA, WASH.:

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A PRELIMINARY REPORT OF A FEEDING TEST WITH SWINE.

E. R. LAKE.

The past year has been one of great trial to the farmers of southeastern Washington—"The Palouse Country." The chief crop of this section is wheat, and anything that seriously lessens its market value works a hardship upon the people of this section. The territory included in the term Palouse country has, at a conservative estimate, an area of about two and one-half million acres. Last year over one-half of this acreage was cropped with three grains—wheat, oats and barley. Of the total crop it is safe to say that nearly, if not quite, a million acres were wheat. In an ordinary year this acreage would yield, at a low figure, twenty million bushels of marketable grain.

The year just past, however, was a most exceptional one in this section, as also in other parts of the state. A cold, backward spring so retarded the growth of the grain crop as to make a late harvest. An autumn of very unusual and heavy rainfall ruined, for ordinary market demands, as a consequence, a vast amount of both headed and threshed grain; while hundreds of acres remained uncut and totally unfit for other than pasturage purposes.

With less than one-half the year's crop saved as first grade grain, and the larger part of this selling for thirty cents per bushel, and the remainder of the marketable grain, not more than one-sixth of the total crop, selling for fifteen to twenty cents per bushel, it is evident that great losses have been sustained through this crop the past year. Estimating one-third of the crop as wholly lost as marketable grain, and one-third as selling at half price, we have, as a total loss to the farmers of this section, the enormous sum of \$2,500,000. These are very conservative figures, based upon reports obtained from our leading farmers and grain brokers.

With large quantities of wheat too wet for the elevators, much of it unthreshed and uncut, on their hands, the problem of disposing of it without suffering total loss has been one of considerable moment to the farmers. To those who have had more or less stock the answer has been comparatively easy; for it has been found by many practical trials that wheat fed to stock has given fair returns. However, thousands of bushels have been quite wholly lost as the amount of available stock for feeding purposes was greatly below the demand for the consumption of so large a quantity in a single season. And, besides, the farmers who had most need for so using their crop had little means for procuring stock, which had a high market value in consequence of the unusual demand, and no conveniences for feeding it profitably. Without barns, sheds or ricks, feeding must be done in the open corral, a most wasteful method in more ways than one, and the result of such feeding has not been entirely satisfactory in the several instances reported by the press of the state.

The outcome of all this has been to cast a cloud over our agricultural interests—to bring about a great temporary depression. Yet, at the same time, these conditions have combined to direct the attention of our soil tillers into other lines of labor than wheat growing, and the outlook for a better system of farming is becoming brighter and brighter day by day. The farmer is doing more thinking and figuring. He is putting more brain work into his business. He is considering the relative merits of the different crops that are available for culture in this section. The pig, the cow, the hen, and their various products, are receiving much attention at the hands of the progressive farmer, and the final issue of this unusual interest in other lines of agricultural labor must be a great revolution in our present system, or, rather, non-system of agricultural practices.

To the end that some close figures might be placed in the hands of interested agriculturists, the Station has undertaken a series of feeding tests with swine. The chief object in view at the beginning was to ascertain the relative value of wheat and barley as feeding stuffs; and how much pork a bushel of grain would produce when fed to the ordinary grade hog of this section, and to the full blood swine of our best breeds as found in the eastern states.

Although the test is hardly more than begun, it has been deemed better to give the partial results obtained than to hold them till the tests are completed, which, from the nature of the case, will cover a considerable period.

On December 2d three hogs were taken from a herd of eight which had been fed for the five previous months on table waste, skim milk and a small amount of wheat and barley ground, or as it is commonly called "chop." The three selected for test were as nearly equal in size and appearance of vigor as it was possible to get from the herd, considering sex—male. On removal from the open corral in which they had been kept they were carefully weighed, and then placed separately in small pens in the basement of the barn. During the first period, of thirty days, weighings were taken each day just before the mid-day meal; during the second period, of twenty-five days, weighings were taken every fifth day at a corresponding time.

Cut straw was used for bedding and the quantity allowed each hog weighed, as was also the waste as it was taken from each pen.

No. 1 for the first eleven days was fed ground wheat alone. The remainder of period one and during period two he was fed whole wheat.

All foods were soaked from twelve to twenty-four hours in an equal amount, or even a little more, of water, before being fed.

No. 2 was fed wheat and barley chop in equal parts during all of period one, and for four days of period two. The remainder of the time wheat chop.

No. 3 was fed wheat and barley chop in equal parts for the first ten days of period one; then barley chop alone for the following thirty-five days, and wheat chop for the last ten days of period two.

The changes in feed were more frequent than they would otherwise have been had our supplies of barley feed not become exhausted before the hogs were sold.

The accompanying chart will afford a means of following with the eye the increase in weight of each hog from weighing to weighing, and at the same time enable one to get, at a glance, the slight differences due to changes of feed.

Feed was given three times a day, and on the average about two and one-half pounds per meal. At the former part of test more was given; at the latter part, less.

From the record of weighings taken we deduct the following accounts:

FIRST PERIOD.

<i>Hog No. 1:</i>	<i>Dr.</i>	<i>Cr.</i>
To original weight, 182 pounds at $3\frac{1}{2}$ c.....	\$6 37	
To wheat, chop, 65 pounds at $7\frac{1}{2}$ c.*	38	
To wheat, whole grain, 196 pounds at $\frac{1}{2}$ c	98	
To salt.....	01	
To straw, cut, 100 pounds at $\frac{1}{4}$ c.....	25	
By weight at end of period, 255 pounds at $3\frac{1}{2}$ c.....		\$8 92
By manure, mostly solids, 315 pounds at $12\frac{1}{2}$ c.† per cwt..		40
Balance, gain	1 33	
	<hr/> \$9 32	<hr/> \$9 32

The gain of \$1.33 represents what is made in feeding 261 pounds of grain over and above what it would bring marketed as grain at one-half cent per pound; or, stated another way, 261 pounds of wheat produced 73 pounds of pork, which, at three and one-half cents live, would net \$2.55 total, or ninety-eight cents per hundred weight, which equals fifty-nine cents per bushel.

One pound of pork produced at a cost of 3.58 pounds of wheat.

<i>Hog No. 2:</i>	<i>Dr.</i>	<i>Cr.</i>
To original weight, 174 pounds at $3\frac{1}{2}$ c.....	\$6 09	
To wheat and barley chop, equal parts, 275 pounds at $7\frac{1}{2}$ c..	1 60	
To straw, cut, 112 pounds at $\frac{1}{4}$ c.....	28	
To salt.....	01	
By weight at close of period, 245 $\frac{3}{4}$ pounds at $3\frac{1}{2}$ c.....		\$8 60
By manure, mostly solids, 392 pounds at $12\frac{1}{2}$ c. per cwt..		49
To balance, gain	1 11	
	<hr/> \$9 09	<hr/> \$9 09

In this instance the feeding of 275 pounds grain, half barley, made 71 $\frac{3}{4}$ pounds of pork, which, at three and one-half cents live, would give a return of \$2.50, or ninety-one cents per hundred weight, which equals fifty-five cents per bushel.

One pound of pork produced at a cost of 3.83 pounds of wheat and barley.

* The cost of chopping with our own machinery has been about $\frac{1}{2}$ c. per pound.

† The value of manure is taken from average estimates made by the chemists of several of our agricultural colleges.

<i>Hog No. 3:</i>	<i>Dr.</i>	<i>Cr.</i>
To original weight, 175 pounds at $3\frac{1}{2}$ c.....	\$6 12	
To wheat chop, 25 pounds at $\frac{7}{12}$ c.....	15	
To barley chop, 230 pounds at $\frac{7}{12}$ c.....	1 34	
To straw, cut, 112 pounds at $\frac{1}{4}$ c.....	28	
To salt.....	01	
By weight at end of period, 247 pounds at $3\frac{1}{2}$ c.....		\$8 64
By manure, mostly solids, 416 pounds at $12\frac{1}{2}$ c. per cwt..		52
To balance, gain	1 26	
	\$9 16	\$9 16

The feeding of 255 pounds of grain, nearly all barley, in this case gave an increase of 72 pounds of pork, which, at three and one-half cents, would bring the price of the wheat up to ninety-nine cents per hundred weight, or fifty-nine and one-half cents per bushel.

One pound of pork produced at a cost of 3.54 pounds of grain, chiefly barley.

SECOND PERIOD.

Hog No. 1.—Consumed 157 pounds whole wheat, and increased from 255 pounds to $286\frac{1}{4}$, a gain of $31\frac{1}{4}$ pounds. This is equal to 5 pounds of wheat to each pound of pork, an increase of 1.42 pounds of wheat over the amount required during the first period to produce a pound of pork.

Hog No. 2.—Consumed $133\frac{1}{2}$ pounds wheat chop and 5 pounds barley chop, and increased from $245\frac{3}{4}$ to $279\frac{1}{4}$, a gain of $33\frac{1}{2}$ pounds. This is equal to 4.13 pounds of wheat to each pound of pork, an increase of .3 pound of wheat over the amount required to produce a pound of pork during the first period.

Hog No. 3.—Consumed during the second period 177 pounds of grain, 85 of which were barley, and gained $38\frac{1}{4}$ pounds in weight. This is equal to 4.6 pounds grain for each pound of pork, an increase of 1.06 pounds grain over what was required to produce a pound of pork during first period.

The average number of pounds of grain required to produce a pound of pork throughout the test for these three hogs was: 4.29 pounds of wheat for No. 1; 3.98 pounds of grain, a little over one-third barley, for No. 2; 4.07 pounds of grain, a little over one-third wheat, for No. 3.

Had the grain been evenly mixed throughout the test, it would seem to indicate that a proportion of two parts wheat to one part

barley would be the best food, but when it is remembered that the barley was fed to No. 2 at the first part of the test, and with an equal quantity of wheat, it is readily seen that a conclusion cannot be safely stated in this respect.

Summary of this partial test would seem to show :

1. With our common grade hog, half grown, one pound of pork can be produced by feeding from $3\frac{1}{2}$ pounds to 5 pounds of grain.
2. The younger the hog the less grain required to produce a pound of meat.
3. That barley chop alone is a more profitable feed than wheat alone, pound for pound.
4. That barley and wheat mixed in the proportions of one to two, respectively, are better than either alone.

At $3\frac{1}{2}$ c. per pound for live hogs it is profitable to feed wheat priced at 40c. per bushel if no better returns than five pounds of grain for one pound of pork are made.

No account has been taken of the labor, as its value to the farmer and his sons at the time of year when little is to be done on the farm is a questionable one, while the ease of marketing a crop of wheat as pork is an item of much weight as against the usual method of marketing the crop.

It must be remembered that allowance is to be made for the small number of individuals in the test. Each hog's "personal equation" enters into the conclusions and may materially affect the finals. Realizing the weight of this condition in the test, we have begun a second test with twenty small pigs, which are being treated alike in all material respects.



Washington State Agricultural College
and School of Science.

Experiment Station

Pullman, Washington.

Bulletin 12.

DEPARTMENT OF HORTICULTURE.
FOREST TREE PLANTATION.

JOHN A. BALMER.

1894.

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PULLMAN, WASHINGTON.

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Forest Tree Plantation.

JOHN A. BALMER.

The problem presented by the Eastern and Western parts of the state, so far as they relate to Forestry, are distinctly different. There are, perhaps, no denser forests in the United States than those in this state West of the summit of the Cascades. The Eastern, and particularly the South-eastern parts of the state, on the other hand, are nearly or quite treeless. It is not the province of this bulletin to inquire into the causes of this condition, but rather to offer suggestions that may be valuable to the treeless portions of the state. With a view to determining the adaptability of trees to this portion of the state, the Experiment Station in the spring of 1892 made large plantings of deciduous and evergreen trees and shrubs as detailed in Bulletin No. 6 of this station. The trees planted here in the spring of 1892 were mostly small—very small—and a great many of them being damaged in transit by frost did not start into leaf at all, hence it would be an error to charge the entire loss in any variety to lack of adaptability to soil and climate. The Northern and North-western portions of the nursery were not well drained, which had an unfavorable effect upon all the plantations there except willows and poplars. The evergreens suffered particularly from this cause. It would appear also that the evergreen stock planted was not in good condition, since very little of it survived the transplanting season. Those that did so have since shown a good growth. Owing to the uncultivated and unimproved condition of the college grounds at the time of the arrival of these trees it was thought advisable to plant them all in nursery rows, where they could have proper cultivation, and where it could be determined which were most desirable for general planting. In the spring of 1895 several thousand of these will be planted

on the campus and in the arboretum. About five acres will be devoted to the arboretum, in which as large a collection as possible will be made. After seeing the growth that these trees have made, we can form a very correct idea of what varieties to recommend for planting in the part of the state east of the Cascade range, where planting is so much needed and where it has been so deplorably neglected. It should be remembered that some trees which are not hardy enough to stand the climate in this latitude may be raised successfully in the warmer and irrigated regions of the Yakima and the Walla Walla valleys. The time has come when the people must awake to the necessity of planting trees. Nothing will so quickly and so effectively change the climatic conditions of Eastern Washington as the planting of trees in large numbers. It is a matter of no small consequence to have groves that may break the monotonous appearance of the landscape. In a land of homes everything that may add to the comfort and pleasure of life is useful, and there is scarcely any more dreary and depressing surrounding than a treeless landscape. It would scarcely be thought worth while to have trees for shade for stock in a climate of cool summers, yet the contrast of our few warmest days of summer makes this a matter of some importance. The value of such plantations for wind breaks not only for the house, the orchard and the stock, but also for its general effect upon the climate, will be readily recognized. Every farmer and land-owner ought to feel that it is his duty to plant a few acres in trees. He should not plant after the fashion of the government "timber culture" plantations, seven-hundred or a thousand to the acre, but should plant a beautiful grove, fifty or seventy trees to the acre, and cultivate it with the same care that he does his orchards. Hoed crops might be cultivated in the grove for several years until the trees are strong and deep rooted enough to withstand the summer drought and the effect of the winds.

The notes taken on the varieties in the nursery rows here will, in a measure, answer the question what to plant. It is particularly recommended that something else besides Box Elder and the Poplars be planted, these being used only when nothing better can be obtained. Some of the more recently introduced Poplars, e. g. the Russian Poplar, however, seem to promise well. The Box Elder and the common Poplars are short-lived and are

almost worthless for timber or fuel. Their quick growth is supposed to be their recommendation, but if after they have grown they are of little value, they will scarcely repay the cost. Another tree might be of slower growth, but it is ornamental when small, and after it has attained its growth it will continue to be useful for a long period.

The following is a list of the varieties planted on the College grounds, together with statistics and notes which will indicate in a pretty definite way the relative value of these varieties in standing the vicissitudes of soil and climate. The proportion that have survived the summers and the winters and the chances of trans-plantation will be a matter of general interest to the public, as will also the growth made by the several varieties:

LIST OF DECIDUOUS TREES AND SHRUBS.

(Height is given in inches.)

Scientific name.	Common name.	No. planted April 1892.	No. surviving May 1893.	Av. height when planted.	Av. height May 1894.	Av. height October 1894.	Hardiness.
<i>Acer pseudo-platanus</i>	Sycamore maple	100	14	5	14	28	Hardy
“ <i>dasycarpum</i>	Silver maple	500	297	7	48	90	“
“ <i>macrophyllum</i>	Large-leaved maple	...	58	..	10	40	Tender
“ <i>platanoides</i>	Norway maple	200	24	5	16	30	Hardy
“ <i>rubrum</i>	Red maple	100	70	9	30	60	“
“ <i>campestre</i>	English maple	100	93	10	42	80	“
“ <i>saccharinum</i>	Sugar maple	...	280	7	20	35	“
“ <i>circinatum</i>	Vine maple	...	13	..	15	35	“
<i>Aesculus hippocastanum</i>	Red-flowered horse [chestnut]	50	43	10	24	38	“
<i>Aesculus hippocastanum</i>	White-flowered horse [chestnut]	100	88	10	24	40	“
<i>Alnus rubra</i>	Red alder	...	14	..	24	36	Not quite hardy
<i>Amelanchier alnifolia</i>	Western serviceberry	...	33	..	42	70	Hardy
“ <i>oligocarpa</i>	Dwarf serviceberry	50	18	10	38	60	“
<i>Asimina triloba</i>	Papaw, Wahoo	50	26	10	..	15	“
“ <i>sp.</i>	European Wahoo	50	22	5	12	26	“
<i>Berberis vulgaris</i>	Barberry	100	19	7	18	48	“
<i>Betula alba</i>	White birch	25	18	10	42	70	“
“ <i>lutea</i>	Yellow birch	100	1	6	24	40	Doubtful
<i>Buxus sempervirens</i>	Box	300	69	7	..	9	Hardy
<i>Calycanthus, sp.</i>	.....	100	1	5	6	..	Not hardy
<i>Carpinus caroliniana</i>	Hornbeam	100	77	10	18	30	Hardy
<i>Carya alba</i>	Hickory	100	0	5	..	..	Doubtful
<i>Castanea sativa</i>	Spanish chestnut	100	80	7	12	28	Fairly hardy
“ <i>var. americana</i>	American chestnut	100	24	7	10	15	“
“ <i>sp.</i>	Japanese chestnut	...	3	..	6	12	“
<i>Catalpa speciosa</i>	Hardy catalpa	200	0	6	..	..	Not hardy
“ <i>bignonioides</i>	Catalpa	100	54	7	24	40	“
“ <i>kaempferi</i>	Teas' catalpa	100	57	7	36	48	“
<i>Celtis occidentalis</i>	Hackberry	50	43	10	36	50	Hardy
<i>Ceanothus velutinus</i>	Elkbrush	...	7	..	18	30	“
“ <i>sanguineus</i>	.....	...	6	..	54	70	“

Cotoneaster simonsii	Rose box	25	21	7	12	24	Hardy
Cornus nuttallii	Dogwood	25	1	10	10	30	Not hardy
“ sanguinea	Red dogwood	75	57	15	18	30	Hardy
“ sp.	Siberian dogwood	50	29	15	30	50	“
Corylus americana	Hazlenut	30	21	10	12	20	“
“ avellana	English filbert	100	85	10	12	24	“
Crataegus tomentosa	Haw	100	56	10	36	55	“
Cytisus scoparius	Broom	100	15	5	24	60	“
Fagus americana	Beech	250	2	7	10	..	Doubtful
Fraxinus viridis	Green ash	100	84	9	36	60	Hardy
“ americana	White ash	100	101	7	30	55	“
“ ornus	Flowering ash	100	98	10	42	65	“
“ Oregana	Oregon ash	....	36	..	30	60	“
Gymnocladus canadensis	Kentucky coffee tree	100	60	7	9	12	“
Juglans cinerea	Butternut	100	86	10	16	20	“
“ nigra	Black walnut	100	61	10	12	20	“
Laburnum vulgare	Laburnum	50	33	..	9	14	“
Ligustrum vulgare	Privet	500	500	10	18	24	“
Lonicera	Red bush honeysuckle	25	10	7	36	50	“
Morus sp.	Russian mulberry	100	10	6	12	18	Doubtful
Negundo aceroides	Box elder	250	32	6	34	50	Hardy
Philadelphus Lewisii	Syringa. Mock orange	....	30	..	24	50	“
Platanus occidentalis	American sycamore	100	25	10	12	16	“
“ orientalis	European “	100	0	10	..	..	Doubtful
Populus balsamifera	Balsam poplar	....	..	..	..	..	Hardy
“ “ var. candicans	Poplar	....	..	..	..	..	“
“ alba	White poplar	....	..	..	..	..	“
“ fastigiata	Lombardy poplar	....	..	..	..	..	“
Prunus serotina	Black cherry	100	73	9	42	65	“
“ sp.	Eaton's plum	....	9	..	54	75	“
“ Virginiana	Choke cherry	100	86	9	36	60	“
“ sp.	Mahaleb cherry	250	41	6	24	40	“
“ sp.	Mazzard cherry	250	95	6	30	50	“
Pyrus aucuparia	European m't'n ash	100	55	5	36	60	“
“ americana	American “	50	49	15	40	55	“
“ sp.	Seedling apple	250	232	10	48	70	“
“ sp.	“ pear	250	99	6	39	60	“
Quercus rubra	Red oak	100	10	5	10	15	“
“ prinus	Chestnut oak	100	21	5	6	11	“
“ robur	English oak	50	39	5	9	14	“
“ alba	White oak	100	40	5	7	12	“
Rhamnus alnifolia	Buckthorn	....	20	..	15	25	“
Ribes sanguineum	Red flowering currant	....	20	..	24	36	“
Robinia pseud-acacia	Black locust	250	77	5	48	65	“
Salix (several species)	Willow	....	..	..	..	60	“
Sambucus racemosa	Red-fruited elder	....	..	..	..	..	Not hardy
Syringa vulgaris	Purple lilac	25	22	5	30	40	Hardy
Spiraea arifolia	Spiraea	....	18	..	54	75	“
Tilia Europaea	Large-leaved linden	....	..	..	..	..	“
“ “	Small “	....	..	..	..	..	“
Ulmus americana	American elm	....	..	..	..	..	“
Virburnum opulus	Tree cranberry	....	..	..	..	..	“

LIST OF EVERGREEN TREES.

Abies grandis	Silver fir	100	25	5	6	9	Hardy
“ balsamea	Balsam fir	100	56	5	8	11	“
Juniperus virginiana	Savin	100	8	5	6	9	“
Larix americana	American larch	100	33	7	12	24	“
“ europaea	European “	100	59	7	20	45	“
Picea alba	White spruce	50	39	7	10	15	“
“ excelsa	Norway “	500	147	5	10	15	“
“ pungens	Colorado blue spruce	100	51	7	12	18	“
“ nigra	Black spruce	100	24	5	10	16	“
Pinus strobus	White pine	250	68	7	8	14	“
“ pungens	Mountain pine	50	50	10	..	..	“
“ laricio	Corsican pine	25	0	..	12	17	Not hardy
“ sylvestris	Scotch pine	100	17	7	12	17	“
“ banksiana	Jack pine	50	6	7	15	20	“
“ mughus	Mugho-dwarf pine	50	50	7	10	14	“
“ austriaca.	Austrian pine	100	41	7	10	14	“
Pinus	Norway pine	9	3	10	12	17	“
Pseudotsuga Douglasii	Douglas spruce	100	81	10	12	18	Hardy
Thuja occidentalis	White cedar	100	56	5	6	9	“
“ gigantea	Giant cedar	....	16	..	4	7	“
“ sp.	T. Thumb arborvitae	50	3	7	6	9	Doubtful
Tsuga canadensis	Hemlock.	100	0	5	..	..	“

ACER. MAPLE.

A valuable and highly ornamental family of trees. The Maples are as a rule symmetrical and regular in outline, beautiful in foliage, vigorous growers, very free from diseases, and adapted to most soils, merits which deservedly render them popular. Some varieties, however, are not hardy here (altitude 2400 ft.), notably acer macrophyllum, the large leaved or Oregon Maple. This is a beautiful shade tree west of the mountains where it is indigeous, and it is much used for street and yard planting there. With us it winter kills badly. In the valley of the Snake River it thrives and forms a handsome tree.

The Silver Maple (*Acer dasycarpum*), is perhaps the very best of all the maples for planting where a rapid growth is desired. The tree is very harly, easily transplanted, grows large in an irregular rounded head. The foliage is bright green above and silvery white beneath. A good tree for street planting, and valuable as a windbreak for orchards and farm buildings. It is as good a nurse tree as Box Elder and much more desirable on account of its utility and freedom from insects. There are several varieties of the Silver Maple, some of them very ornamental, notably the cut leaved kinds, which are mostly dwarf and suitable as planting as solitary specimens in yards and parks.

As a family the Maples cannot be too highly praised; they are all beautiful, and are to be highly commended for planting in our state.

The Sugar Maple (*Acer saccharnum*), is a fine tree; one of the most desirable for ornamental purposes. A very large percentage of those planted survived, seem perfectly hardy and show good growth. Larger trees planted on the college campus have also done remarkably well. It is of rather slow growth, particularly in the earlier years, but grows more rapidly later. It is strongly recommended for this part of the state.

The Sycamore Maple, Norway Maple and English Maple are also recommended. Ninety-three per cent. of the latter grew, and from an average of ten inches at time of planting grew to forty-two inches in the two years.

ÆSCULUS HIPPOCASTANUM—HORSE CHESTNUT.

On our grounds we have the red and the white flowered varieties of these truly beautiful trees. They promise to do well here, having made a satisfactory growth and show great hardiness.

Specimens planted in a yard in Pullman not over six years ago bore several flowers the past year.

Though very useful for yard and street planting, they are not very suitable for a grove unless put in the outside row. The wood is not very valuable.

BETULA. BIRCH.

On our trial grounds are two varieties of this truly beautiful genus. All the Birches are highly ornamental. Their elegant, slender branches, silvery bark and light airy foliage render them general favorites as single specimens on the lawn or employed as avenue trees. They are very imposing and handsome. They have done well with us and will be largely planted on the campus and in the arboretum.

CARPINUS. HORNHEAM.

This is a dwarf tree, grows fifteen to twenty feet high, and is very similar to the Beech in habit of growth. Planted close it forms a very effective wind-break. And clipped it makes a very handsome hedge. Very hardy and is sure to do well in Washington.

CATALPA.

Several varieties of Catalpa were planted here for trial. We cannot recommend them, however, as they winter kill very badly, and the cold winds in spring shrivel the foliage. In the more sheltered parts of our state they ought to do well, and their large beautiful leaves render them desirable for ornamental trees when the climate is sufficiently mild.

FRAXINUS. ASH.

All the varieties of Ash planted here in 1892 have done remarkably well. Mere switches when planted, they are now (September) fine young trees, six to eight feet high, good bodies and nice foliage. For permanent plantation all the varieties of Ash are very desirable. Twenty-five feet each way is enough for ash, and they should be planted in the center of the grove, for they grow tall and form nice heads.

NUT-BEARING TREES.

It is a pleasure to record the success that has been attained with Walnuts in this vicinity. On a ranch about two miles from the College grounds, belonging to Mr. J. H. Burnham, are growing Walnut, Bitternut, Hickorynut and Shell-bark Hickory, quite a number of trees, all about ten years old. For several

years past these trees have borne quite a number of nuts. They are fifteen or twenty feet high, thrifty and vigorous and are forming splendid heads. They have had very little cultivation except what the hogs have given them. Mr. Burnham, being an extensive hog raiser, uses the grove for a hog lot to the benefit of the trees, apparently. The excellent showing these trees have made augurs well for the future of nut growing in this part of the state. Amongst the smaller nuts, English and American Filberts have made a good growth and promise to do well. The Spanish Chestnut, though growing slowly in this locality, is a very beautiful ornamental tree suitable for yard planting.

It is strongly recommended that groves of nut-bearing trees be planted. These not only add to the comforts of the farmer's home, but may become a very considerable source of revenue.

PLATANUS.—PLANE TREE, SYCAMORE OR BUTTON WOOD.

This well-known, hardy and beautiful tree is well adapted for most kinds of ornamentation. Whether planted in a grove or by itself, it is always the same imposing tree. It is not particular as to soil, thriving equally well on the sandy hill or the loamy valley. It has one bad fault—the dropping of its leaves too early in the fall. The foliage, too, is rather scanty.

POPULUS. POPLAR.

If it is desired to fill in a spot quickly, to make a wind-break or hide an unsightly object, there is hardly any tree that will do it as soon as the Poplar.

Some five or six varieties of Poplar were planted on our trial grounds, and all without exception have done well. They have outstripped everything else in growth except the Willows and possibly the Silver Maple. They are easily propagated from cuttings, and as they adapt themselves to almost every condition, they have become even more popular than they deserve. For they are, as a rule, short lived, have no value as timber, very few of them are really beautiful, and, at least so far as the Native and Lombardy Poplars are concerned, are very subject to aphids and other insect pests. The Russian Poplars that we have observed on our grounds and in the vicinity have done very nicely and are fine looking trees. Some specimens in Mr. Reaney's grove, near the College grounds, are among the most attractive and largest trees in the grove.

MOUNTAIN ASH.

There are several varieties of these truly beautiful trees, than which there is no finer for lawn ornamentation. We have growing *Pyrus Americana*, American Mountain Ash, and *Pyrus Aucuparia* or European Mountain Ash. Both have done well and cannot be too highly commended for planting in small yards. The beautiful clusters of bright red berries in the later summer and fall afford a fine contrast to the dark green foliage. They grow fifteen to twenty feet high in this altitude.

QUERCUS. OAK.

The several kinds of Oak planted here have made very little growth compared to the other growing trees in the nursery rows. It must be borne in mind, however, that the Oak is a slow grower and a very long-lived tree. Oaks might be planted, if not for your own, for the enjoyment of your descendants.

The Royal Oak, (*Q. robur*), has done best amongst those planted here.

ROBINA. LOCUST.

A hedge of Black Locust, (*R. Psend-acacia*), that was planted here two years ago has made very satisfactory growth.

There are several varieties of Locust; all suitable for road-side or grove planting, and are all desirable trees. Their timber is valuable for fence posts, and the bees gather large quantities of fine nectar from the flowers.

SALIX. WILLOW.

"They grow as easily as a Willow," is a common expression. There are ten or more varieties of Willow native to our state. Wherever there is moist ground, there Willows will grow. While the Willow has no timber value, yet it forms an ornamental object for the landscape. If you wish Willows, get cuttings in the fall or spring and stick them in where you want them to grow and you will soon have some shrubbery at least.

TILIA. LINDEN OR LIME TREE. BASSWOOD.

The Lindens are all beautiful, and merit a great deal more attention than they usually receive. There is no more beautiful shade tree than the Linden, excellent for grouping or planting as a solitary object. In bloom, the Linden has a very delicate perfume. It is also a fine honey plant. For a row to border a drive nothing is finer than the Linden, either European or American varieties. They grow in beautiful proportions and give a pleas-

ing effect to the landscape.

ULMUS. ELM.

Many of the Elms are so well known that it is unnecessary to call attention to their great value as timber and shade trees. They are exceedingly desirable as ornaments for parks and drives as well as for solitary objects for large lawns. Elms planted a year ago in Reaney's grove, before referred to, have shown a remarkable growth. Where rapid growth is very desirable the Elm would be recommended as much to be preferred to the shorter lived trees so commonly selected. By all means plant Elm.

There are many varieties. All more or less beautiful. The Elms planted here have made a good growth and promise to do well in future.

EVERGREENS.

Washington is the Evergreen State. Her list of deciduous trees is very short indeed, especially as compared with the Evergreen. This would indicate the probability of the successful planting of Evergreens in our treeless regions. The list of Evergreens that I would recommend to plant for shelter and wind-breaks is not very long.

ABIES, THE FIR. PICEA, SPRUCE. TSUGA, THE HEMLOCK.

First I would mention *Picea Alba*, White Spruce, a valuable variety varying in height from 25 to 100 feet, foliage silvery gray, with light colored bark. The tree assumes a beautiful form and is perfectly hardy.

Douglas Spruce, (*Pseudotsuga Douglasii*), is one of our native species. A beautiful tree, very much sought after by European planters, and is regarded as one of the very best Evergreens for forest planting.

BLUE SPRUCE. PICEA PUNGENS.

Is found quite plentifully in the low range of hills some fifteen miles east of the College grounds. One of the hardiest and most beautiful of Spruces. The foliage is of a rich blue-green color. It is very handsome as a single specimen or in groups.

NORWAY SPRUCE. PICEA EXCELSA.

This well-known Spruce has, perhaps, been more largely planted than all the other Spruces put together. As a wind-break it is

invaluable, perfectly hardy and feathers close to the ground. Three or four rows planted moderately close together on the windward side of an orchard will be found a great protection. Evergreens should be cultivated several years after planting, or until they are thoroughly established.

SILVER FIR. A. CEPHALONICA.

The Silver Firs are all worthy of cultivation, and some of them should be included in every collection of any size.

Pinus Mungus, or Dwarf Pine, however, should be mentioned. This species did finely and is a beautiful shrub for lawn ornamentation. The Pines, the Yews, the Cypress, *Arbor Vitae*, etc., might be mentioned, but the Evergreens in the Station plantings, have, as a rule, not done well. This is, no doubt, partly due to the bad condition of the stock planted.

Amongst the coniferous trees planted here, none have done better than the Larch, *Larix laricina*. *L. Americana*.

They have made rapid and healthy growth and promise to make their mark amongst the trees planted in Washington. Our native Larch, (*L. occidentalis*), was not in our planting, but it would seem to promise as well as the other varieties. Seeds of most of our coniferous trees can easily be collected in September and October, and the seed ought to be planted at once.

This rule applies to all forest trees. When the seed is ripe is the time to plant it. Sow thinly by hand in rows or drills about an inch deep and cover lightly, then with the feet tramp firmly down. Cultivate carefully until large enough to transplant, then lift carefully and plant in their permanent home, being careful to give the roots plenty of room and adjust them carefully.

HEDGE PLANTS. FOR ORNAMENTS.

For this purpose we recommend several of the Evergreens, such as American and Siberian *Arbor Vita*, Norway Spruce, Australian and Scotch Pines, and many of the deciduous and Evergreen shrubs such as Japan Quince, *Tanarix*, Barberry, Hawthorn, Hornbeam, etc.

The finest Evergreen hedge I have ever seen was one of Hemlock Spruce, (*Abies Canadensis*).

The Yew makes a very beautiful and long-lived hedge, as also does the Holly. Tree Box is an excellent hedge plant and is always beautiful, winter or summer.

The American Barberry (*B. variegata*), makes a very beautiful

hedge. And for those who cannot spare the time to trim a hedge this plant is very desirable. It has beautiful yellow flowers in the spring, followed by red berries in the fall.

Amongst hedge plants for defensive purposes, to turn cattle, etc., I would recommend Honey Locust, Osage Orange, our native Hawthorne, etc. The seed of the latter can be gathered in the fall and planted where it is intended to grow the hedge. To have the best success with a hedge the young plants ought to be clipped or pinched when they are very young, so as to keep the bottom of the hedge quite full. Deciduous hedge plants can be planted any time after the leaves have fallen and when the ground is not frozen. Spring is the best time to transplant all Evergreen trees and shrubs.

NOTES MAY, 1894.

DECIDUOUS TREES AND SHRUBS.

Sycamore Maple—Although a comparatively small portion of this species survived, it seems a good tree. Not a rapid grower

Silver Maple—The best Maple for rapid growth. Should be planted for groves in preference to Box Elder.

Large-leaved Maple—A native west of the Cascade mountains. The young shoots winter-kill badly with us.

Norway Maple—The trees look healthy but have made but little growth.

Red Maple—A rapid grower. The tips of the shoots winter-kill occasionally.

English Maple—A handsome, compact, rapid growing species.

Sugar Maple—An excellent tree, but slower of growth than other Maples.

Vine Maple—A small but ornamental Maple, native to Western Washington. Requires moist ground.

Red and White-flowered Horse Chestnut—Both of these are rapid growers.

Red Alder—Another tree native west of the Cascades. The young shoots winter-kill with us.

Western Serviceberry—Our common native species. Apparently an excellent shrub for a hedge or a wind-break.

Dwarf Serviceberry—Very similar to the above in all respects.

- Barberry—An excellent hedge plant. Berries edible.
- White Birch—The trees have made excellent growth. A promising ornamental tree.
- Yellow Birch—The only surviving tree looks healthy.
- Hornbeam—A good ornamental tree of fairly rapid growth.
- Hickory—All of our specimens are dead. Cause unknown.
- Spanish Chestnut, American Chestnut and Japanese Chestnut—None of these species are doing well.
- Hardy Catalpa, Catalpa and Teas' Catalpa—None of the first species remain. The others grow rapidly but winter-kill badly. A slight frost of May 11, this year, killed back the growing shoots several inches.
- Hackberry—This tree is a native; a rather slow grower, but desirable both for shade and for ornament.
- Elkbrush and —————Both of these are native shrubs and desirable for ornaments.
- Rose Box—A well-known ornamental shrub.
- Dogwood—Native of Western Washington. Too tender for our climate.
- Red and Siberian Dogwood—Both of these are rather tall ornamental shrubs.
- Hazlenut and English Filbert—Both species do well.
- Haw—A good hedge plant, but perhaps no better than our native specie.
- Broom—A rapid growing hedge or ornamental shrub. The tips of the branches winter-kill slightly.
- Beech—Has done very poorly.
- Green Ash, White Ash, Flowering Ash and Oregon Ash—All of these Ashes have made excellent growth, are perfectly healthy, and, taken all in all, among the best trees in the lot.
- Kentucky Coffee-tree—A very ornamental tree. The branch tips winter-kill slightly.
- Butternut—These have made a satisfactory growth, and appear promising.
- Laburnum—Does very well. A fine ornamental shrub.
- Black Walnut—A good hardy tree.
- Privet—An excellent garden hedge plant.
- Red Bush Honeysuckle—An ornamental shrub.
- Russian Mulberry—The specimens do not look healthy, and are

more or less winter-killed.

Syringa or Mock Orange--A native shrub of high ornamental value.

American Sycamore--The trees do not seem healthy.

Balsam Poplar, Poplar, White Poplar and Lombardy Poplar--

All forms of these Poplars have made a large growth.

Black Cherry--A fine hedge plant.

Choke Cherry--Nearly the same as our choke cherry and in all respects very similar.

Mahaleb Cherry--A very good plant for dense hedge.

European Mountain Ash and American Mountain Ash--Both of these are rapid growers.

Red Oak, Chestnut Oak, English Oak and White Oak--These oaks are doing well, but are of slow growth.

Buckthorn--A native shrub or small tree of ornamental value.

Red-flowering currant--A highly ornamental shrub native to Western Washington. The tips winter kill slightly.

Black Locust--An excellent tree.

Willow--All of these willows do well but for most purposes are little better than native species.

Spiræa--A native ornamental shrub.

Large-leaved Linden--Hardy.

Small-leaved Linden--Hardy. A much better tree than the preceding.

American Elm--Hardy. Has made a splendid growth.

Tree Cranberry--Hardy.

EVERGREEN TREES AND SHRUBS.

Silver Fir--A native species. Has not done well.

Balsam Fir--Grows only fairly well.

Savin--Done very poorly.

American Larch and European Larch--Both of these varieties have done very well. The European species seems to be the more rapid grower.

White Spruce, Norway Spruce, Colorado Blue Spruce and Black Spruce--All of these shrubs have made a satisfactory growth. The Norway and White Spruces are the best in appearance, but have not grown so rapidly as the Blue Spruce.

White Pine, Mountain Pine, Corsican Pine, Scotch Pine, Jack Pine, Mugho Dwarf Pine, Austrian Pine and Nor-

way Pine—Excepting the Corsican species, all these Pines are healthy and have made good growth.

Douglas Spruce—Our common native fir. Although considered one of the best, it has done very poorly with us.

White Cedar—Has made but little growth, though the plant seems perfectly healthy.

Giant Cedar—Our native cedar. Has not done well.

Tom Thumb Arbor Vitae—A very small ornamental species. Does not seem hardy.

NOTES.

Additional notes were taken on the growth of the trees in the fall of 1894 after they had made their full growth. The progress made by the trees was very satisfactory. Some species, however, did much better than others. The silver maples lead all the others in length of shoots—many of the new growths being 60 to 65 inches long. The poplars are a close second in size, especially the Lombardy. Many of them are now over 7 ft. high and in good proportion. The ash in its several varieties still maintain the places given them in the fore part of the bulletin. Shoots of 4 to 5 feet long are quite common. The English maples made quite a remarkable growth and promise to be very useful trees for ornamental planting and ought to be valuable as wind-breaks as they have a tendency to grow very bushy as seen here on our trial grounds. The elm does very well but has a tendency to branch out right down to the ground, in fact this habit of brushing out very low, instead of growing straight up and forming a nice tree seems to prevail in almost all the forest trees we have tried. This habit is especially noticeable in the lindens, maples and elms. The seedling apple, pear and cherry have made very satisfactory growth and are very bushy. This habit of growing bushy all trees and shrubs seem to take on here ought to be in favor of making very fine hedges. A plant that is useful in forming hedges in other localities is doubly so here owing to this tendency. Among the hedge plants on trial the Scotch broom leads all in length of growth. It will require severe pruning, if in rich soil, to keep it in bounds of a low hedge. It has the additional good quality of being evergreen.

WIND-BREAKS.

In a treeless country like Eastern Washington where the winds have a clear sweep for many miles across the undulating plains, the question of wind-breaks is a very important one. There can be no question that the evergreens are the best trees to plant for shelter, and of all evergreens the spruces and firs must have first choice. The Norway spruce (*Abies excelsa*) has been used largely for this purpose and is certainly well adapted for the purpose. Its great hardiness, rapid growth, beautiful form and drought resisting qualities claim for it a place in the first rank of trees suitable for a wind-break. Several of our native spruces are quite as valuable as the Norway variety and are certainly more

easily obtained. The white spruce (*Abies alba*), the Douglass spruce (*Abies Douglasi*), the Colorado blue spruce (*Abies pungens*), and several of the silver firs, especially Nordman's silver fir, or Russian fir as it is often called (*Picea Nordmannana*) are all exceedingly well adapted to forming shelter, whether it be to orchards or farm buildings. None of the deciduous trees will compare with the above as a protection against wind. Prof. Edward J. Wickson recommends the apricot as a wind-break. Judging from its rapid growth and numerous branches, planted close and left unpruned it might prove valuable in our state. The best wind-break that I can recommend would be three rows of

one of the above evergreens planted thus — — — — —
— — — — —

15 feet between the rows and the same number of feet between plants in the rows. It is unnecessary to state that the rows of trees ought to be planted on the side of the orchard or buildings from which the prevailing winds come. Spring is the best time to plant evergreens and the best success is obtained if the planting is done after settled weather has come and just as the trees are commencing to make new growth. After planting, having exposed the roots as little as possible to sun and air, thoroughly water every tree so as to settle the soil firmly about its roots. A mulch of course litter around the tree will be of benefit the first season, and frequent waterings the first two seasons ought to be resorted to. Plow the ground between the rows once a year with a breaking plow until the trees are big enough to interfere with the operation. This will encourage the trees to root deeply where they will be less affected by drouth. A cheap but somewhat short-lived wind-break can be made by planting any of the close-growing poplars. The Lombardy is probably best for this work. Plant 8 to 10 feet apart and 5 to 10 rows wide, cultivate each season with shovel cultivator until the trees become well established. A better shelter than the poplars can be made of European larch (*Larix Europea*) and silver maple (*Acer dasycarpum*), planting first a row of maple and then a row of larch—three or four rows of each. Plant not closer than ten feet—fifteen feet is better—between the rows and the same distance in the row. It may be remarked that a deciduous wind-break is only effective in summer and that it will require two or three times the amount of land on which to plant a deciduous wind-break to that required for one composed of evergreens alone. So that evergreens at 20 cents each would be cheaper than deciduous trees at half the price and would besides make a better shelter and use less land.

WASHINGTON STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE.

EXPERIMENT STATION,
PULLMAN, WASHINGTON.

BULLETIN 13.

DEPARTMENT OF CHEMISTRY.

WASHINGTON SOILS.

By ELTON FULMER, A. M., and
C. C. FLETCHER, B. Sc.

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WASHINGTON SOILS.

ELTON FULMER, A. M.

C. C. FLETCHER, B. SC.

The chemical department of this Station began last fall the work of an exhaustive soil survey of the state. It is, perhaps, needless to remark that this work will of necessity require a number of years for its completion. Information and data are being compiled from field work as well as from the results of analyses. It is expected that this survey, when completed, will be of much value to the agricultural and horticultural interests of Washington.

The work embodied in this bulletin is but a very small beginning. The mechanical analysis of these same soils will be performed as soon as possible; and the mechanical and chemical analysis of new samples will be carried on as rapidly as other work will permit. The larger part of the analytical work herein represented has been most ably performed by Mr. C. C. Fletcher, the assistant chemist.

The following bulletin is but a preliminary one, and is only issued at this time to meet the demands that have been made for some definite knowledge of the composition of Washington soils. This demand is rapidly increasing, both in the eastern and western portions of the state, and comes from farmers, fruit growers, gardeners and capitalists.

The varieties of soil found in the state are so numerous, and the climatic conditions in different portions so very unlike, that it often becomes a difficult and sometimes impossible task to determine, without analytical aid, whether the failure or poor development of certain plants should be attributed to a deficiency in the soil, to climatic conditions, or to both causes. In traveling through the different sections of the state, one may not infrequently see total or partial failures of crops that are due to none of the above causes,

but are very largely the result of improper cultivation. It is not the purpose of this bulletin to criticise the methods of cultivation (perhaps more correctly, lack of methods) employed by many engaged in farming in this state. We would suggest, however, that the matter of proper cultivation be carefully considered before condemning any soil as unfit for the production of given crops, and before calling upon the chemist to determine its weak point. Many so-called poor soils will be as much or more benefited by a generous application of intelligence and industry than by the use of manufactured fertilizers.

The following pages contain the results obtained from the analysis of twenty soils from various portions of the state. "Is this a good beet soil?" "Will prunes and hops do well on this soil?" "Will it pay to fertilize such land?" and many other questions of a similar character, accompanied these samples.

In order to make a discussion of the analysis of soils more easily comprehended, a few words concerning their origin and general make-up will be necessary.

ORIGIN OF SOILS.

All soils are produced by the decomposition or disintegration of the original rock masses. We are apt to look upon rocks as being very durable, and so they are. But they are not proof against the action of certain agencies that are continually at work tearing them apart and breaking them in pieces. The most important of these agencies are water, air and frost. All rocks are more or less porous, and absorb considerable water, which freezes during the cold weather. The tremendous expansive force exerted when water changes to ice is well known, and this force is sufficient to tear the rocks apart. The rapidity with which rock decomposition is carried on from this cause is proportional to the porosity of the rock and severity of the frosts.

Many rocks contain compounds which are capable of uniting with oxygen under ordinary conditions. The air furnishes this oxygen, and the chemical changes produced by such a combination often result in fracturing the rock.

The grinding power of moving glaciers has also played an important part in the formation of soils.

It naturally follows that soils will resemble in composition the rocks from which they are derived. The disintegration of a sand-

stone and a limestone will produce soils having characteristics which differ as much as do the rocks themselves.

Were it not for the transportation agencies of wind and water, soils would always consist of the decayed underlying rock, enriched by the decomposition products of the vegetable matter which they support. But because of the ease with which they are transported by these agencies, it frequently happens that a fertile soil is found in regions underlaid by rocks which by their decomposition would yield one nearly barren. Equally true is it that a barren soil is often found overlying rocks that contain all the elements essential to fertility. Ordinarily, however, unless there is clear proof to the contrary, we may assume that the rocks of a given locality have furnished the material for the soils of that section. This being true, it becomes evident that geology and agricultural chemistry are closely allied. A knowledge of the geological formations of any section gives at once a clue concerning the general character of the soil.

The term "soil" is used to designate that mixture of mineral (earthy) matter and decayed vegetable matter in which plants grow, and from which they derive much of their food. Soils should not be considered as indefinite masses of dirt, in which plants grow through the agency of mysterious forces. Although it is true that they possess distinct features indicative of their origin, it is equally true that they have many things in common.

There can be no effect without an adequate cause. Hence when soils present to us different degrees of fertility, we must conclude that these variations have some cause, which may be easily traced to inherent qualities which they possess. All soils wherever found have certain fixed and definite properties; and it has been satisfactorily proven that barrenness and fertility depend upon the absence or presence in them of those forms of mineral matter that are to be found in the ashes of plants, and also upon the degree of availability of this matter.

Subsoil in distinction to surface soil is that portion lying directly under the latter. In many cases there is a clear line of demarcation between them, the subsoil usually being lighter in color because containing less humus. In other cases it is impossible to distinguish any marked difference for a depth of many feet. This is a characteristic feature of the glacial drift of Clarke county, and the soils of basaltic origin in Eastern Washington. In regions of

abundant or excessive rainfall the differences between surface soil and subsoil are usually very important and striking, but in dry regions they are often barely perceptible.

While the subsoil has an important function in the economy of plant growth, the surface soil is what concerns us most. As already stated, it consists of the products of rock decomposition enriched by decayed organic matter. When a soil is heated to redness a portion of it passes away, and that which remains generally assumes a reddish color. This remaining portion is the inorganic matter, and what passes away is the organic substance, and combined water.

COMPOSITION OF SOILS.

1. Organic Portion.

This organic matter is very complex, consisting of decomposition products intermediate between woody fibre and the gases into which vegetable matter is finally resolved by complete decomposition. Although all fertile soils contain some organic matter, it is not essential to fertility that any given proportion of it should be present. It is found to vary from $1\frac{1}{2}$ per cent. to 50 per cent., and in peaty soils, as high as 70 per cent. It seems to make very little or no difference in the fertility of normal soils, whether the minimum or maximum amount is present. A small proportion of the organic matter is in the form of "humus," which is a mixture of several of the intermediate stages of decay. This humus, to which the dark color of many soils is apparently due, is a very important constituent of soils, inasmuch as it furnishes the nitrogen so necessary for growing vegetation. It was formerly supposed to be an absolutely necessary soil factor. We now know that this is not true, but yet we recognize its value not only as a source of nitrogen, but also for its influence on the physical conditions of soils. It gives them an increased power of retaining moisture, makes them more responsive to solar heat, and renders them more easy of tillage.

2. Inorganic Portion.

The inorganic or mineral portion forms in ordinary soils by far the greater part of their bulk and weight. This portion is also complex, and, as said above, consists of a mixture of substances all of which are found in the ashes of plants. There are eleven or twelve of these substances found in all soils, whether fertile or

barren. Some of them act mechanically only by giving to the soil the necessary bulk, porosity and water holding power. Others act more directly by furnishing materials which the plant requires. The value of a soil for agricultural purposes depends much upon the proportions in which these elements are present, but perhaps more upon the *form* in which they occur. A soil may contain in abundance all the elements of fertility, and still be barren. This is because the material required by the plant must be in solution before it can be assimilated, and, although present in abundance, it may be in an insoluble form. In such a case an application of fertilizers will be just as essential to productiveness, as in case of a soil wholly destitute of mineral plant food.

The mineral substances that are present in varying proportions in all soils are silica, iron, alumina, lime, magnesia, soda, potash, phosphoric acid, sulphuric acid, chlorine, and sometimes manganese and fluorine. In order to better understand the following analytical results, some of the chief characteristics of these substances are given below.

Silica is a compound of the elements silicon and oxygen. It not only forms the basis of most soils, but is the most abundant solid material of the earth. The quartz crystal is pure silica. Sand and clay are largely composed of it. It is present in soils in greatly varying proportions, sandy soils having from 70 to 90 per cent., while lime soils and marl contain as low as 20 to 30 per cent. It occurs mostly in an insoluble condition, in which state its action is merely mechanical. Most fertile soils contain some of it in a soluble form, and then it becomes a source of plant food.

Iron, in the form of finely diffused ferric hydrate, is a constituent of all soils. Its percentage varies from $1\frac{1}{2}$ to 20 per cent. and often gives the color to red soils. Yet it frequently happens that a soil distinctly red in color contains less iron than one that has a much darker color. This is well illustrated by samples Nos. 5 and 19, given in the following pages. No. 5 is a dark colored soil, while No. 19 is a sample of the characteristic red soil of Western Washington; but they contain equal amounts of ferric hydrate. The color apparently depends more on the mode of distribution than on the quantity. As a rule, soils rich in iron are poor in organic matter, although their fertility is very great. The beneficial effects of iron are largely mechanical, increasing the power of the soil to absorb and retain heat and moisture, and rendering tillage easier in clay lands. The green

color of plants is due to the presence of iron in the soil, and undoubtedly other of its beneficial effects are due to chemical causes; but this latter point is as yet somewhat obscure. Soils having slight color contain from $1\frac{1}{2}$ to 4 per cent., ordinary loams from 4 to 7 per cent., red lands from 7 to 12 and occasionally as high as 20 per cent.

Alumina combined with silica forms pure clay. The clays in soils have usually a reddish color, due to the oxide of iron they contain. Alumina does not directly contribute to the growth of plants; it is seldom absorbed by their roots and therefore is not direct food for them. In the form of clay, however, it is a most essential constituent of the soil. Clay, as well as humus and ferric hydrate, is very retentive of water, and has the power of absorbing and retaining the easily soluble compounds supplied by manure and other fertilizers. This property of clay prevents these fertilizing substances from being washed out of reach of the roots of plants by the first heavy rain. Clay is derived mainly from the decomposition of rocks containing feldspar, and hence is frequently associated with a considerable supply of potash. The alumina ranges from 1 to 4 per cent. in sandy soils to 6 to 10 per cent. in clay soils.

Lime. In regard to the presence of lime in soils, Prof. Hilgard says: "Other things being equal, the thriftiness of a soil is measurably dependent upon a certain minimum percentage of lime." As the results of a certain definite amount of lime in a soil, the following points are found true:

- (1) A more rapid transformation of vegetable matter into humus.
- (2) The retention of humus against the oxidizing effects of hot climates.

- (3) Whether through the medium of this humus, or in a more direct manner, it renders adequate for profitable culture percentages of phosphoric acid and potash so small that in case of a deficiency of lime or its absence the soil would be practically sterile.

- (4) It tends to secure the proper maintenance of the conditions of nitrification, whereby the inert nitrogen of the soil is rendered available.

This controlling influence of lime renders its determination alone a matter of no small interest, since its deficiency can very generally be cheaply remedied. Lime is among the most variable of soil constituents, existing in all proportions from mere traces to 30 per

cent. in limestone soils. It is usually found in the form of calcium carbonate (limestone), calcium sulphate (gypsum), or calcium phosphate. Gypsum is somewhat soluble in pure water, and the carbonate and phosphate are soluble in rain water by virtue of the carbonic acid it contains. Hence, all three of these forms are capable of furnishing the lime so necessary for vigorous plant development. It is of unusual importance as a soil constituent, inasmuch as it is not only a necessary ingredient of plants, but it exerts a peculiarly beneficial effect on the physical properties of the soil.

Magnesia. This substance resembles lime in many of its properties, and is generally found accompanying it in rocks, especially in dolomite, or magnesian limestone. Epsom salts is a compound of magnesia with sulphuric acid. Magnesia is found in all cultivated soils, and seems to be essential to the healthy development of many plants. There is much evidence that a supply of it in the soil is necessary for the full development of wheat, barley, oats and similar plants. However, it seems to have no direct action on the soil. Although it is an important ingredient of plant ash, yet, unaccountable as it may seem, soils derived from magnesian limestones are invariably less fertile than those derived from pure limestones.

Potash. Ashes that result from the burning of wood consist, for the most part, of potash, or, more correctly, carbonate of potash. Ashes in general are simply the mineral substances required by the plant, and taken from the soil during their growth, and generally contain from 10 to 15 per cent. of potash. As already indicated, potash is derived, together with alumina, from the decomposition of rocks containing feldspar. It is a most important element of plant food, and is usually present in soils in an available form, in quantities sufficient for many years of productiveness.

Soda is very closely allied to potash, both in its chemical and physical properties. It is, however, much less important as a soil ingredient, and is present usually in smaller quantities. When combined with chlorin to form common salt, it is very injurious, even in very small quantities.

Phosphoric acid occurs in all fertile soils, although usually in much smaller amounts than the other important ingredients. It never occurs free, but in combination with either iron, alumina or lime, phosphate of lime being most common. Because all crops take it from the soil, and because of the small amount present in most of them, decidedly beneficial effects are usually produced by

adding it as a fertilizer. The question of profit resulting from its application can only be determined by trial.

Sulphuric acid is found as one of the constituents of most soils, although present in minute quantities. It is usually in the form of calcium sulphate, or gypsum.

Chlorin is found only sparingly in soils, and is usually in the form of common salt.

Value of a Chemical Soil Analysis.

It has become very evident from correspondence and conversation with parties interested in the relation of soils to agricultural and horticultural interests, that the prevailing idea concerning the real value and meaning of a chemical soil analysis is far from being the correct one. Therefore, it seems best at this point to outline, as clearly as possible, the true importance to be attached to such an analysis.

Agriculture, as a science, is of comparatively recent date. As recently as 1830 it was still an unsolved problem whether or not mineral matter was necessary to the life of the plant. Since that time the ideas concerning the relation between the plant and the soil in which it grows have been varied and conflicting, always governed and modified by the theories of the time. Real scientific agriculture only dates back about thirty-three years, when Liebig first discovered the true philosophy of plant nutrition. His discovery was not made until he had learned by bitter experience that theories, however plausible, are often disproved by practical tests. Liebig's examination of plants from many portions of the world was very productive of results. He found that all plants contained the same ash constituents, although varying in proportion for different plants. From this he argued that all plants take from the soil certain mineral substances, and that unless these forms of plant food were returned to the soil, fertility would be seriously impaired by continuous cropping. Upon this theory the manufacture of artificial fertilizers was founded. Because of mistaken conceptions of the nature of plant food, fertilizers were at first prepared in the most insoluble form possible; and hence, when applied to the soil, did not yield the expected beneficial results. It was not until others discovered that plant food must be soluble in order to be assimilated that artificial fertilizers became of value.

When it first became known that the ashes of plants, and soils,

were alike in their composition, it was at once assumed that there was a direct relation between them, and that chemical analysis would reveal that relation. It was supposed that if a given soil refused to produce a profitable crop, an examination of its ash, and of the soil, would show what the latter lacked that was required by the former. But when put in practice it was soon found that analyses frequently showed no deficiency in the elements of plant nutrition, and yet the plant would not grow. For this reason, it was then as well as now a dangerous matter for the chemist to state dogmatically that a given soil must be productive because he has found it to contain all that plants require; because a practical test may prove his statements to be false. This is one reason, and perhaps the chief one, why many have been in the past, and some are to-day, skeptical concerning the ability of chemical science to render any practical assistance to agriculture.

When it was also discovered that the differences between a new, fertile, uncultivated soil, and one that has been worn out by long continued culture, are so slight that even the delicate balance of the chemist can barely appreciate them, doubts began to arise in the minds of chemists themselves as to the usefulness of chemical soil analyses. In their opinions on this point, chemists disagree very widely.

The weak point of an analysis is the fact that, while it reveals what the soil contains, and in what proportions the different constituents are present, *it does not show how much of the plant food present is in a form suitable for assimilation by the plant.* Other things being equal, the productiveness of any soil should be proportional to the amounts of *available plant food which it contains.* When it becomes possible to show by an analysis how much of the plant food present is capable of being absorbed by the roots, then soil analysis will have reached a point where its practical utility cannot be questioned.

A very large portion of the future farming land of our state is as yet uncultivated, virgin soil. A chemical soil analysis will always show whether or not there is a *deficiency* of any of the elements of plant food. It is pretty generally agreed that an investigation of virgin soils is a fruitful field of work. We know that plants differ in their requirements upon the mineral food of the soil. Hence it is possible for the chemist to determine in his laboratory what the farmer can only determine by the costly experi-

ment of crop failures. While the analysis can not demonstrate with certainty that the soil of any given locality is unfitted for the successful production of any given crop, yet it may indicate a reasonable probability of success or failure. Many important points concerning the needs of soils that have long been under cultivation might be revealed by analyses, although it must be admitted that the results are less satisfactory than in the case of virgin soils.

The chemical constitution of soils, as important as it is, is not the only determining factor of fertility. Equally, or perhaps even more important, are its *physical characteristics*. The availability of plant food is probably largely conditioned by the size of the grains. Hence the determination of the dimensions of the soil particles is important. It is now also generally accepted as true, that the water holding power of soil, its permeability to air and water, and all of its relations to moisture, have much to do with fertility or barrenness.

We have taken up this work on Washington soils—

(1) Because we believe that the chemical, supplemented by the physical analysis, can furnish us with valuable results in case of our virgin soils; results which, when taken in connection with a knowledge of their geological history, will at least enable us to predict relative to their durability.

(2) Because, in the case of cultivated soils, the experiences and results of cultivation, together with the analysis, may furnish us data that will be valuable in their future cultivation and fertilization.

(3) Because a more definite knowledge of our soils, their composition and needs, is exceedingly valuable to the horticultural as well as the agricultural interests of the state.

The information desired by the intending settler or land purchaser will usually include the following points:

(1) Is the land in question capable of yielding profitable crops without fertilization or other expensive improvements; and, if so,

(2) How long is it likely to hold out under ordinary (exhaustive) culture before it will require fertilization?

(3) When it does "give out," or seriously slackens its production, what fertilizer will it require first?

(4) To what crop is the land, from its (physical and chemical) nature, best adapted?

A chemical investigation, carried out in the manner indicated,

would certainly give us much clearer notions of the relative productiveness of different soils than any mere summing up of soil constituents ever can. It would throw much light on the above points of information desired by the intending settler, and such questions as the following would receive definite answers:

(1) Whether or not barrenness is caused by the presence of injurious substances, such as sulphate or sulphide of iron?

(2) Whether barrenness is due to the presence of common salt, nitrates, or other soluble compounds which are useful to vegetation in a highly diluted state, but are injurious when too abundant.

(3) Whether barrenness is caused by a deficiency of any important element of plant food.

(4) Whether or not land will be improved by liming.

(5) What artificial fertilizers are best adapted to soils of various compositions.

Interpretation of Results.

To insure the highest degree of fertility under suitable climatic conditions, it is necessary that a soil should not only contain sufficient available mineral food for the plant, but it should be loose enough and porous enough to admit of easy tillage, and to allow the air to have free access to the plant roots. This will be the case if sufficient sand be present, or in case of a very clayey soil, if the humus or lime be present in sufficient quantity to cause the clay particles to aggregate. On the other hand, the soil should be compact enough to be able to resist drouth. An experienced farmer may be able to determine by the eye whether a soil possesses these requisites of porosity and compactness. In the laboratory the same points are determined by the mechanical analysis. As said above, the chemical analysis shows how much plant food is present, but does not show the form in which it occurs.

Having obtained the percentage composition of any given soil, the next thing is to interpret it, "for a mere column of figures opposite another column of unintelligible names does not convey much meaning to the farmer." *Are the various percentages represented higher or lower than necessary?* The answer to this question can only be given tentatively, inasmuch as so many conditions may influence fertility. We may assert positively, however, that if a soil shows by analysis a high percentage of plant food, it will also show high productiveness, provided the physical conditions

favor the growth of the plant. On the other hand, low percentages of plant food do not necessarily mean low productiveness.

Among all the constituents of soils, there are only three that are of "critical" importance to the plant. That is, "of the different inorganic or mineral elements which enter into the composition of plants, only three are required to increase and maintain the fertility of the soil. These are phosphoric acid, potash and lime." The agriculturist need not concern himself about the others.

It must not be thought, however, that the latter have no effect on plants. They are no less necessary than these three; and if they can be dispensed with in artificial fertilizers, it is only because the poorest soils are already sufficiently provided with them.

Assuming, then, that soils contain in superabundance all of the elements except the three above mentioned, we need pay little attention to the percentages of any save these three.

Prof. Hilgard says:

"The *lime* percentage should not fall below 0.1 per cent. in the lightest sandy soils; in clay loams not below 0.25 per cent., and in heavy clay soils not below 0.5 per cent.; and it may advantageously rise to 1 and even 2 per cent. as a maximum. Beyond the latter figure it seems in no case to act more favorably than a less amount, unless it be mechanically.

"The percentage of *phosphoric acid* is that which, in connection with the lime, seems to govern most commonly the productiveness of our virgin soils. In any of these, less than 0.05 must be regarded as a serious deficiency, unless accompanied by a large amount of lime. In sandy loams, 0.1 per cent., when accompanied by a fair supply of lime, secures fair productiveness for from eight to fifteen years; with a deficiency of lime, twice that percentage would only serve for a similar time.

"The potash percentages of soils seem, in a large number of cases, to vary with that of 'clay;' that is, in clay soils they are usually high, in sandy soils low; and since subsoils are in all ordinary cases more clayey than surface soils, their potash percentages are almost invariably higher.

"The potash percentage of heavy clay upland soil, and clay loams, ranges from about 0.8 to 0.5 per cent.; lighter loams from 0.45 to 0.30 per cent.; sandy loams below 0.3 per cent. and sandy soils of great depth may fall below 0.1 per cent. consistently with good productiveness and durability. Virgin soils falling below 0.6 per cent. in potash seem in most cases to be deficient in available potash, its application to such soils being followed by an immediate great increase of production. Sometimes, however, a soil very rich in lime and phosphoric acid, shows good productiveness, despite a very low potash percentage, and conversely, a high potash percentage seems capable of offsetting a low one of lime."

These pages concerning the interpretation of results should be carefully studied in connection with the analytical tables.

The following analyses were made by the method recommended by the Association of Official Agricultural Chemists, with some slight and unimportant modifications. They represent in all cases the analyses of "fine earth" which would pass through a sieve containing holes one-half millimeter in diameter.

The nitrogen was determined by the Kyehldahl method, and humus by the method of Grandeau.

Soil No. 5.

	<i>Per cent.</i>
Insoluble residue.....	76.4944
Insoluble silica.....	62.8314
Combined silica.....	13.6630
Soluble silica.....	.3010
Potash (K_2O).....	.6351
Soda (Na_2O).....	.3739
Lime (CaO).....	1.0814
Magnesia (MgO).....	.7277
Peroxid of iron (Fe_2O_3).....	4.5539
Alumina (Al_2O_3).....	7.5263
Phosphoric acid (P_2O_5).....	.1423
Sulphuric acid (SO_3).....	trace.
Chlorin.....	.0204
Water at $120^{\circ}C$	4.5234
Volatile and organic matter.....	3.6124
Total.....	99.9922
Humus.....	.9950
Nitrogen.....	.1096

Sample No. 5 was taken from the College farm. It is the characteristic heavy, dark soil of the Palouse country, containing practically no sand, and is what is ordinarily termed a clay loam. The sample was taken from an uncultivated, unfertilized spot, where the soil is about two feet deep, with a clay subsoil.

The high content of lime, phosphoric acid and potash shown by the analysis explains why soils of this type have not apparently decreased in fertility after having been cropped with wheat for fifteen or more successive years. The amount of nitrogen present is satisfactory, though not large. It is probable that nitrogenous fertilizers will be first required in order to maintain the fertility of this type of soils. While it has not apparently suffered from continued cropping without any restoration of the elements of food used by the plant, yet it is reasonably certain that its fertility would be largely increased by a judicious application of manure.

Soil No. 11.

	<i>Per cent.</i>
Insoluble residue.....	78.7114
Insoluble silica.....	65.7684
Combined silica.....	12.9430

Soluble silica.....	.0156
Potash (K_2O).....	.3315
Soda (Na_2O).....	.5687
Lime (CaO).....	1.5125
Magnesia (MgO).....	1.5274
Peroxid of iron (Fe_2O_3).....	4.6101
Alumina (Al_2O_3).....	5.9300
Phosphoric acid (P_2O_5).....	.1823
Sulphuric acid (SO_3).....	trace.
Chlorin.....	.0152
Water at 120° C.....	2.7313
Volatile and organic matter.....	3.7452
Total.....	99.8812
Humus.....	.6100
Nitrogen.....	.1409

Sample No. 11 was taken from the orchard of J. B. Holt, at Waiwai, Whitman county, about two hundred yards from Snake river. It consists very largely of sand intermingled with considerable fine mica. From its physical appearance, one would hardly suspect it capable of sustaining much plant life. However, it would be difficult to find a more vigorous or better bearing orchard than the one growing in this sandy soil. Everything seems to indicate that the soil has been formed by "wash" from the river. The high percentage of lime is doubtless due to the presence of shells that have been reduced to a finely divided state. It also seems probable that the presence of so much phosphoric acid may be due to other forms of river waste. In a different type of soil, the comparatively high percentage of soda might indicate a tendency toward alkalinity — but here it has no special significance.

Soil No. 16.

	<i>Per cent.</i>
Insoluble residue.....	77.7110
Insoluble silica.....	60.6690
Combined silica.....	17.0420
Soluble silica.....	.4650
Potash (K_2O).....	.5308
Soda (Na_2O).....	.3236
Lime (CaO).....	1.1800
Magnesia (MgO).....	.7339
Peroxid of iron (Fe_2O_3).....	4.2705
Alumina (Al_2O_3).....	6.3703
Phosphoric acid (P_2O_5).....	.1392
Sulphuric acid (SO_3).....	trace.
Chlorin.....	.0048
Water at 120° C.....	2.6341
Volatile and organic matter.....	5.5002
Total.....	99.8634
Humus.....	1.2211
Nitrogen.....	.1120

Sample No. 16 was also taken from the farm of J. B. Holt, at Wawaiwai, Whitman county, from cultivated land lying near the foot of the hills which rise abruptly from Snake river. The soil is made up of both river wash and hill wash, and is very productive. It is a light colored soil, easily worked, and composed very largely of fine earth. It differs from No. 11 in containing only a small amount of true sand and very little mica. The amount of lime is less than in No. 11, but is still notably large. It is also noticeable that the percentages of potash and soda are reversed—the ratio between them being practically the same—but No. 11 contains more soda, and No. 16 more potash. Because of the large amounts of lime, potash and phosphoric acid, this soil should theoretically be productive for a long period. It is interesting to note that the combined percentages of iron and alumina are the same in both samples; also, that the sulphuric acid is present in both in mere traces only.

Soil No. 17.

	<i>Per cent.</i>
Insoluble residue.....	78.4340
Insoluble silica.....	60.2070
Combined silica.....	18.2270
Soluble silica.....	.2100
Potash (K_2O).....	.4328
Soda (Na_2O).....	.3739
Lime (CaO).....	1.2127
Magnesia (MgO).....	.7880
Peroxid of iron (Fe_2O_3).....	5.1586
Alumina (Al_2O_3).....	6.8906
Phosphoric acid (P_2O_5).....	.1007
Sulphuric acid (SO_3).....	trace.
Chlorin.....	.0058
Water at 120° C.....	3.4527
Volatile and organic matter.....	3.0195
Total.....	100.0793
Humus.....	.2550
Nitrogen.....	.0876

Sample No. 17 was sent from North Yakima, Yakima county, by Alfred M. Miller, having been taken from the southwest quarter, section 12, township 14 north, range 18 east. It is locally termed the "bench" or "sage brush" soil. Being in the area of limited rainfall, irrigation is necessary to produce successfully anything but grease wood and sage brush. Sample was taken from surface to a depth of eighteen inches from uncultivated land. It is a light sandy loam.

In this irrigated district no difficulty is experienced in raising excellent crops of cereals, fruit, alfalfa, hops, etc., wherever water

is available. This fact having been determined by practical experience, it is no surprise to learn from a chemical analysis that the soil, so unpromising in appearance, contains such abundant stores of the elements of plant nutrition. It is probable that when partial exhaustion occurs a potash and nitrogen fertilizer will be first required for its restoration to fertility.

Soil No. 19.

	<i>Per cent.</i>
Insoluble residue.....	80.6100
Insoluble silica.....	70.9610
Combined silica.....	9.6490
Soluble silica.....	.4200
Potash (K_2O).....	.2022
Soda (Na_2O).....	.2785
Lime (CaO).....	.6550
Magnesia (MgO).....	trace.
Peroxid of iron (Fe_2O_3).....	4.5351
Alumina (Al_2O_3).....	7.1591
Phosphoric acid (P_2O_5).....	.0384
Sulphuric acid (SO_3).....	trace.
Chlorin.....	.0029
Water at $120^\circ C$	1.7773
Volatile and organic matter.....	4.5651
Total.....	100.2436
Humus.....	1.8960
Nitrogen.....	.1023

Sample No. 19 has a marked reddish color; contains considerable fine sand, but no gravel. It was sent from Anacortes, Skagit county, by Graham Bros., and was accompanied by the following description: "This red soil is the characteristic soil of Western Washington, and is supposed to be glacial drift. The soil where the sample was taken from has never been cultivated or manured. It is supposed to be a good fruit soil. The subsoil is hardpan, very hard to dig, but when exposed to the air it crumbles and becomes very mellow. There are large quantities of mica in it."

This soil is notably deficient in potash and phosphoric acid, and an increase in the lime percentage would probably result beneficially to the soil. Practical experience may already have proven its adaptability to fruit culture; but from a theoretical standpoint, we should not consider it well suited for that purpose, inasmuch as fruit is supposed to require for its highest development considerable quantities of lime, potash and phosphoric acid. It seems probable that an application of fertilizers containing all three of these ingredients would greatly strengthen the soil, either for raising fruits, vegetables or cereals.

Soil No. 20.

	<i>Per cent.</i>
Insoluble residue.....	75.8550
Insoluble silica.....	66.6680
Combined silica.....	9.1870
Soluble silica.....	.0330
Potash (K_2O).....	.0077
Soda (Na_2O).....	.2865
Lime (CaO).....	.7690
Magnesia (MgO).....	.4261
Peroxid of iron (Fe_2O_3).....	3.5870
Alumina (Al_2O_3).....	6.4646
Phosphoric acid (P_2O_5).....	.0544
Sulphuric acid (SO_3).....	.0384
Chlorin .....	.0066
Water at 120° C.....	3.1200
Volatile and organic matter.....	9.1600
Total.....	99.8083
Humus.....	2.0010
Nitrogen.....	.2345

Sample No. 20 is a grayish colored soil, containing considerable sand and some coarse gravel. It was also sent by Graham Bros., of Anacortes, Skagit county, with the following description: "This is what is known as 'alder bottom land.' It has been cultivated and planted in orchard for six years. Land originally covered with cedar, alder and maple timber, and salmonberry bushes. No manure has been used. Average depth of soil, fifteen inches." Same subsoil as No. 19.

The analysis shows, in this soil, a grave deficiency in potash. The potash percentage is naturally low, and in case of this sample the supply has been exhausted by growing nursery stock for five years. The phosphoric acid is low, but yet sufficient with the amount of lime present to produce high fertility. While the supply of potash is supposed to be of vital importance, yet there are cases on record where it was present in very small amounts in a soil that produced good fruit. It is very evident that field crops would fare poorly upon it in a very few years without the addition of potash and phosphatic fertilizers. An application of potash now would, doubtless, increase the profits derived from fruit grown upon it. Its nitrogen content is good.

Soil No. 21.

	<i>Per cent.</i>
Insoluble residue.....	28.3520
Insoluble silica.....	21.6490
Combined silica.....	6.7030
Soluble silica.....	.1808
Potash (K_2O).....	.1366

Soda (Na_2O).....	.1910
Lime (CaO).....	.3790
Magnesia (MgO).....	.0361
Peroxid of Iron (Fe_2O_3).....	1.0550
Alumina (Al_2O_3).....	4.3012
Phosphoric acid (P_2O_5).....	.3135
Sulphuric acid (SO_3).....	.0934
Chlorin.....	.0183
Water at 120°C	11.7600
Volatile and organic matter.....	52.8739
Total.....	99.6908
Humus.....	6.9154
Nitrogen	1.3466

Sample No. 21 is a marsh soil, also sent by Graham Bros., from Anacortes, Skagit county. It has been drained one year, but never cultivated. It has an average depth of four feet, and is underlaid by a stratum of clay two feet thick, which rests upon the hardpan that underlies Nos. 19 and 20.

This sample contains large amounts of moisture and organic matter, which are characteristic of marshy soils. Soils of this type are especially adapted to raising celery, cranberries, peppermint, etc. The composition of this sample does not differ materially from the Michigan "celery soils," although somewhat lower in lime, potash and phosphoric acid. It has been commonly supposed that oxide of iron is an injurious ingredient in celery soils. If this be true, this muck should be well adapted to celery growing, because of the unusually small amount of oxide of iron it contains. The percentage of nitrogen, although large, is yet smaller than in the Michigan celery soils.

Soil No. 22.

	<i>Per cent.</i>
Insoluble residue.....	82.9840
Insoluble silica.....	69.4010
Combined silica.....	13.5830
Soluble silica.....	.0577
Potash (K_2O).....	.1120
Soda (Na_2O).....	.4165
Lime (CaO).....	1.1128
Magnesia (MgO).....	.0317
Peroxid of iron (Fe_2O_3).....	4.1633
Alumina (Al_2O_3).....	6.1328
Phosphoric acid (P_2O_5).....	.0799
Sulphuric acid (SO_3).....	.0109
Chlorin.....	.0099
Water at 120°C	2.1667
Volatile and organic matter.....	3.0933
Total.....	100.3715
Humus.....	.0593
Nitrogen .....	.0107

Sample No. 22 is the clay underlying No. 21. It was asked concerning this clay, "Does it contain any fertilizing properties that would be beneficial to the other soil?"

It is not probable that this clay could be used to advantage or profit in supplying deficiencies in plant food that exist in Nos. 19, 20 and 21.

Soil No. 25.

	<i>Per cent.</i>
Insoluble residue.....	79.0610
Insoluble silica.....	68.4150
Combined silica.....	10.6460
Soluble silica.....	.9850
Potash (K_2O).....	.5908
Soda (Na_2O).....	.0584
Lime (CaO).....	.3625
Magnesia (MgO).....	.2810
Peroxid of iron (Fe_2O_3).....	6.4625
Alumina (Al_2O_3).....	7.2316
Phosphoric acid (P_2O_5).....	.3535
Sulphuric acid (SO_3).....	trace.
Chlorin.....	.0179
Water at 120° C.....	1.8534
Volatile and organic matter.....	2.7341
Total.....	99.9917
Humus.....	.3551
Nitrogen.....	.1780

Sample No. 25 was sent from Vancouver, Clarke county, by Nat. M. Norelius. It was taken from the upward slope, about two miles from the Columbia river, to a depth of 18 inches. It is a red soil, very similar in appearance to No. 19 from Skagit county. Mr. Norelius writes:

"All fruits seem to do well in this soil and climate. The staple fruit raised is the prune, although apples, pears, peaches and cherries do remarkably well. Among the small fruits, strawberries and blackberries do well. The idea is very prevalent here that manuring is necessary in order to get the best results in raising fruit, especially prunes. As barn yard manure is getting to be a scarce article, commercial fertilizers will sooner or later become a necessity. Therefore, if, through the efforts of your station, some light be thrown in regard to what elements of plant food are most deficient in our soil, it will be a public good. The land from which this sample was taken was originally covered with fir, dogwood, maple, hazel, willow, etc."

It is interesting to note that two soils resembling each other as closely as Nos. 19 and 25 differ very materially in their chemical composition. No. 19 is very poor in phosphoric acid, while No. 25 contains an unusually large supply; No. 19 contains less than half as much potash as No. 25, but nearly twice as much lime. From

the generally accepted views concerning the relations of lime and phosphoric acid in the economy of plant nutrition, we might suppose that these two soils would be equally productive and perhaps equally durable. There are many reasons for believing that a large amount of lime in a soil renders available for plant assimilation, very small amount of phosphoric acid, thus making sufficient for the demands a supply which, in the absence of lime, would be far inadequate. Hence, it is likely that only a limited amount of the large phosphoric acid percentage in No. 25 can be used by the plant, because of the unusually low content of lime. An addition of land plaster to such a soil would undoubtedly increase both the productiveness and longevity.

This soil varies from four to sixteen feet deep, resting on gravel. It has very superior drainage and its great adaptability to the culture of Italian prunes is probably due as much to the drainage and climatic conditions as to the food elements it contains. Clarke county is the prune county of the state, and a greater part of the crop is raised within a few miles of Vancouver.

Soil No. 26.

	<i>Per cent.</i>
Insoluble residue.....	77.1730
Insoluble silica.....	64.8150
Combined silica.....	12.3580
Soluble silica.....	.0880
Potash (K_2O).....	.2338
Soda (Na_2O).....	.4404
Lime (CaO).....	.3978
Magnesia (MgO).....	.0316
Peroxid of iron (Fe_2O_3).....	8.3194
Alumina (Al_2O_3).....	7.3245
Phosphoric acid (P_2O_5).....	.1983
Sulphuric Acid (SO_3).....	.0110
Chlorin.....	.0033
Water at 120° C.....	2.2933
Volatile and organic matter.....	3.3467
Total.....	99.8611
Humus.....	.2139
Nitrogen.....	.0558

Sample No. 26 is the same as No. 25, taken from between eighteen and twenty-four inches deep. There is very little change in the appearance of this soil throughout its entire depth.

The analysis, shows with increasing depth, a slight increase in lime percentage, but a tremendous decrease in the amounts of potash and phosphoric acid. The most marked feature of difference is in the relative amounts of soda in the two samples.

Soil No. 27.

	<i>Per cent.</i>
Insoluble residue.....	60.4910
Insoluble silica.....	45.4490
Combined silica.....	15.0420
Soluble silica.....	.0253
Potash (K_2O).....	.0154
Soda (Na_2O).....	.4643
Lime (CaO).....	.1090
Magnesia (MgO).....	.0226
Peroxid of iron (Fe_2O_3).....	6.0888
Alumina (Al_2O_3).....	9.4315
Phosphoric acid (P_2O_5).....	.1407
Sulphuric acid (SO_3).....	.0079
Chlorin.....	.0149
Water at 120° C.....	12.8533
Volatile and organic matter.....	10.4267
Total.....	100.0914
Humus.....	.4227
Nitrogen.....	.2321

Sample No. 27 was sent from Willapa, Pacific county, by Thomas Dixon, jr., and was taken about two miles west of Willapa. Mr. Dixon writes: "This is bottom land, alluvial soil, four feet deep, clay subsoil resting on soapstone. Will hops, prunes and plums flourish thereon? The climate is favorable. This soil yields potatoes at 200 to 300 bushels per acre. Timothy four to five tons per acre. One acre in hay and one in pasture is more than required by one cow. Carrots take the soil by riot, and cabbages are perfectly at home."

While the testimony in the above letter shows the soil to be very productive for some things, the analysis reveals that its productivity cannot probably last very long because of the very low percentages of lime and potash. The supply of phosphoric acid is satisfactory, but it is doubtful if much of it is in an available form for use of the plant, because of the very low lime content, and large amounts of iron and alumina. Some of the bottom lands in the Willapa valley, that have been in cultivation for from ten to twenty years, show very marked indications of a decline in productiveness. An addition of lime to this soil would be of great value in maintaining its fertility. The increase of lime would tend to render more of the phosphoric acid available, and, in that event, the supply of potash would probably be sufficient for some time to come.

This soil would not be very well adapted to fruit culture, especially of prunes and plums, because of the clay subsoil, indicating rather poor drainage, and because of its low percentage of lime.

Apples would probably thrive for a time, but would soon require the soil to be enriched with potash.

The soil from which this sample was taken has grown two good crops of timothy.

Soil No. 28.		Per cent.
Insoluble residue.....		64.0540
Insoluble silica.....		45.0780
Combined silica.....		18.9760
Soluble silica.....		.0430
Potash (K_2O).....		.2770
Soda (Na_2O).....		.4377
Lime (CaO).....		.0828
Magnesia (MgO).....		.0658
Peroxid of iron (Fe_2O_3).....		6.4807
Alumina (Al_2O_3).....		9.4547
Phosphoric acid (P_2O_5).....		.3006
Sulphuric acid (SO_3).....		.0247
Chlorin.....		.0099
Water at 120° C.....		9.6800
Volatile and organic matter.....		8.6933
Total.....		99.6042
Humus.....		.1910
Nitrogen.....		.0463

Sample No. 28 was also sent from Willapa, Pacific county, and Mr. Dixon writes as follows concerning it: "This is a sample of our much despised hill land. The soil is two feet deep, with clay subsoil resting on soapstone. It is known to suit clovers or deep rooted plants, and wheat, orchard grass and oats do well. Pears, plums, and some varieties of apples, such as Rhode Island Greenings, Ben Davis and Baldwins do well; but Spitzenbergs and Yellow Pippins don't thrive. Timothy does not do well. Will this be a good prune soil?"

This sample is distinctly reddish in color and contains more sand than No. 27. The potash in this soil is satisfactory, and the phosphoric acid is present in quantities much greater than necessary were it all in an available form. However, as in case of No. 27, probably only a very small fraction is available because of the very great deficiency in lime. This would be a good strong soil if it could have from 0.6 to 1 per cent of lime. It would not be well adapted to stone fruits for the same reasons as given under No. 27. It must be limed before durability can be assured.

Soil No. 29.		Per cent.
Insoluble residue.....		69.6529
Insoluble silica. }		69.6529
Combined silica }		

Soluble silica.....	.0220
Potash (K_2O).....	.4486
Soda (Na_2O).....	.5041
Lime (CaO).....	.7810
Magnesia (MgO).....	.1228
Peroxid of iron (Fe_2O_3).....	4.8229
Alumina (Al_2O_3).....	8.1376
Phosphoric acid (P_2O_5).....	.3455
Sulphuric acid (SO_3).....	.0494
Chlorin.....	.0066
Water at $120^\circ C$	3.4933
Volatile and organic matter.....	11.6133
Total.....	100.0000
Humus.....	3.4655
Nitrogen.....	.7203

Sample No. 29 was taken from the garden of A. L. Smith, about twelve miles northeast of Spokane. The garden lies at the foot of "Mica" mountain, and comprises about seven acres of land lying in rather a low spot and almost surrounded by hills. The soil has evidently been transported to this spot by the action of water, and consists mainly of the wash from the higher elevations in the vicinity, greatly enriched by the accumulation of organic matter from the decaying vegetation of many years. It contains a large amount of mica (muscovite), owing to the fact that granite is the characteristic rock of the locality.

This soil has never been fertilized and has yielded three excellent crops of celery, which has a delicacy of flavor that is unsurpassed. The garden is irrigated by a little natural stream that flows through it. Theoretically this is the strongest soil, and gives greater promise of durability than any that have been analyzed in our laboratory. The percentages of potash and phosphoric acid are all that could be desired in a soil of this type, while the amount of lime is sufficient to make a large amount of the latter available by combining with it to form the soluble calcium phosphate. This soil contains no organic matter in the form of woody fiber, and hence does not approach peat or muck. The decomposition has gone so far that a very large amount of humus is present, which contains a high proportion of nitrogen. This fact doubtless explains, in part at least, the adaptability of this soil to raising celery and vegetables. It is noticeable that, although the organic matter is only slightly in excess of the amount contained in No. 27, the percentages of humus and nitrogen are very much greater.

This garden lies near "Saltese" lake or marsh, but on somewhat higher ground.

Soil No. 31.		Per cent.
Insoluble residue.....		57.9929
Insoluble silica.....		43.6196
Combined silica.....		14.3732
Soluble silica.....		.2750
Potash (K_2O).....		.6505
Soda (Na_2O).....		1.0763
Lime (CaO).....		.4315
Magnesia (MgO).....		.0334
Peroxid of iron (Fe_2O_3).....		9.7362
Alumina (Al_2O_3).....		13.8841
Phosphoric acid (P_2O_5).....		.5438
Sulphuric acid (SO_3).....		.0258
Chlorin.....		.0249
Water at $120^\circ C$		5.9200
Volatile and organic matter.....		10.2400
Total.....		100.8343
Humus.....		2.2064
Nitrogen.....		.5211

Sample No. 31 was sent by O. P. McFall, of Portland, Oregon. It was taken from about fifteen miles east of Vancouver, Clarke county, from virgin soil. It is a brown soil of loose texture, and well drained. It has a depth of from four to six feet, and rests on gravel.

The sample contains the highest percentage of phosphoric acid of any sample yet analyzed. It has an ample supply of potash, but there is too little lime to guarantee longevity. With the addition of lime this would doubtless make a very durable fruit soil. It is located in the prune belt of the county.

The humus and nitrogen percentages are high.

Soil No. 32.		Per cent.
Insoluble residue.....		56.9087
Insoluble silica... }		56.9087
Combined silica }		
Soluble silica.....		.0155
Potash (K_2O).....		.0126
Soda (Na_2O).....		.9338
Lime (CaO).....		.1303
Magnesia (MgO).....		.0334
Peroxid of iron (Fe_2O_3).....		3.1047
Alumina (Al_2O_3).....		8.4270
Phosphoric acid (P_2O_5).....		.3118
Sulphuric acid (SO_3).....		.0090
Chlorin.....		.0199
Water at $120^\circ C$		7.3200
Volatile and organic matter.....		23.1733
Total.....		100.0000
Humus.....		3.9797
Nitrogen.....		1.1290

Sample No. 32 was also sent by O. P. McFall, of Portland, Oregon, and was taken from the same locality as No. 31. In many places of Clarke county, there are patches of ground, varying in size, in which the soil is much darker colored than the surrounding soil, and which are said to raise excellent crops of wheat. This sample is from one of these spots. As in case of No. 31, the high percentage of soda would indicate alkaline tendencies, if the soil were found in a region of scanty rainfall. The sample is very deficient in lime. The percentage of phosphoric acid, although high, will probably soon require an addition of lime to increase its availability. The potash, although low, would be sufficient for a long time if lime were added. The nitrogen content is unusually high.

Soil No. 33.

	Per cent.
Insoluble residue.....	74.1593
Insoluble silica... }	74.1593
Combined silica. }	
Soluble silica.....	.2105
Potash (K_2O).....	.0474
Soda (Na_2O).....	.2361
Lime (CaO).....	.3980
Magnesia (MgO).....	.0182
Peroxid of iron (Fe_2O_3).....	5.1544
Alumina (Al_2O_3).....	7.8630
Phosphoric acid (P_2O_5).....	.3998
Sulphuric acid (SO_3).....	trace.
Chlorin.....	.0199
Water at 120° C.....	3.6267
Volatile and organic matter.....	7.8667
Total.....	100.0000
Humus.....	1.9435
Nitrogen.....	.3729

Sample No. 33 was sent from Lookout, Skagit county, by J. P. Reid. Concerning this soil he writes: "This is a fair sample of the soil in about forty sections in townships 36 and 37 north, range 3 east, with the exception that it is taken from a heavy timber burn of twenty or thirty years ago, and I do not think it contains as much vegetable matter as the bulk of this tract of land. This soil rests on a slaty quartz formation, while the surrounding country (outside these forty sections) is a sandstone formation. Aside from fir, cedar, hemlock, vine maple, and cherry, there is almost no vegetation except tall fern and the dewberry. I have no success on this soil with red or white clover, timothy, blue grass, red top, orchard grass, alfalfa, vetch or buckwheat. The soil is about two

feet deep and rests on a subsoil composed of a mixture of gray clay, sand and gravel."

The same remark applies to this as to all the soils of Western Washington, concerning lime. The lime percentage is too low to insure productiveness for a long period. The potash percentage is also very low, while the phosphoric acid is high. The amount of nitrogen is sufficient. While the soil would be greatly benefited by the application of fertilizers containing lime and potash, the analysis does not reveal a deficiency of plant food that would account for the failure of grasses and clovers to thrive. Such failure must be due either to climatic conditions, or to peculiar physical features of the soil. In appearance it does not differ from most of the coast soils.

The chemical analysis throws very little light upon the causes of a lack of productiveness. A mechanical analysis may reveal them.

Soil No. 34.

	<i>Per cent.</i>
Insoluble residue.....	81.3580
Insoluble silica.....	48.4460
Combined silica.....	32.9120
Soluble silica.....	.1410
Potash (K_2O).....	.1200
Soda (Na_2O).....	.4722
Lime (CaO).....	.6755
Magnesia (MgO).....	.1163
Peroxid of iron (Fe_2O_3).....	1.8086
Alumina (Al_2O_3).....	2.5917
Phosphoric acid (P_2O_5).....	.1727
Sulphuric acid (SO_3).....	.0494
Chlorin.....	.0111
Water at 120° C.....	4.9200
Volatile and organic matter.....	7.8000
Total.....	100.2365
Humus.....	2.1905
Nitrogen.....	.4390

Sample No. 34 was sent by H. W. McCann, of Pine City, Whitman county. No data accompanied it except the name "white earth," by which it is locally known. It is a very light, ashy looking material, and resembles quite closely in appearance the white silicate so common in western Nebraska and Colorado.

It contains sufficient amounts of lime, potash and phosphoric acid for plant nutrition, and has remarkably high percentages of humus and nitrogen for such a light, siliceous substance.

A somewhat similar substance in appearance and composition is occasionally found, at a depth of eighteen to twenty-four inches, in

the Sunnyside district of Yakima county, underlying a soil that is said to grow only small sage brush.

Soil No. 39.

	<i>Per cent.</i>
Insoluble residue.....	80.6234
Insoluble silica.....	68.2064
Combined silica.....	12.4170
Soluble silica.....	.2127
Potash (K_2O).....	.2748
Soda (Na_2O).....	1.2013
Lime (CaO).....	.9790
Magnesia (MgO).....	.0159
Peroxid of iron (Fe_2O_3).....	5.4860
Alumina (Al_2O_3).....	5.6074
Phosphoric acid (P_2O_5).....	.1663
Sulphuric acid (SO_3).....	.0429
Chlorin.....	.0083
Water at 120° C.....	1.9333
Volatile and organic matter.....	3.1467
Total.....	99.6980
Humus.....	.6898
Nitrogen.....	.2360

Sample 39 was sent by John R. Reavis, of Spokane. It was taken from the farm of E. E. Ellis, twenty miles south of Ritzville, Adams county. The soil is a light sandy loam "and seems to extend all the way down to the hard rock, fifty to seventy feet below."

The analysis shows an abundance of lime and phosphoric acid, but rather too small an amount of potash, and too much soda, for a typical soil of strength and durability. The proportion of iron is greater, and of alumina less, than in most soils of this class. The depth of this soil and its wealth of lime and phosphoric acid should make it a good soil for fruits, if it were in a belt of proper climatic conditions.

Soil No. 40.

	<i>Per cent.</i>
Insoluble residue.....	80.4464
Insoluble silica.....	67.2544
Combined silica.....	13.1920
Soluble silica.....	.3527
Potash (K_2O).....	.0582
Soda (Na_2O).....	.2916
Lime (CaO).....	1.7580
Magnesia (MgO).....	.6477
Peroxide of iron (Fe_2O_3).....	5.5162
Alumina (Al_2O_3).....	6.7589
Phosphoric acid (P_2O_5).....	.1599
Sulphuric acid (SO_3).....	.0551
Chlorin.....	.0133
Water at 120° C.....	1.6667
Volatile and organic matter.....	3.3667
Total.....	101.0914
Humus.....	.5446
Nitrogen.....	.1670

Sample No. 40 was also taken in Adams county, only a few miles from No. 39, from the farm of E. Leonard. Sent by John R. Reavis of Spokane.

A comparison of the composition of these two soils shows no material differences except in case of lime and the alkalies. No. 40 contains nearly twice as much lime as No. 39, but a much smaller proportion of soda and potash. The tendency to alkalinity shown in No. 39 by the large amount of soda, is not seen in No. 40. It is probable that both soils will be exhausted of their potash sooner than anything else. Even now, potash fertilizers would, doubtless, produce an increased yield, especially with plants producing starch, such as potatoes.

Soil No. 41.

	<i>Per cent.</i>
Insoluble residue	75.1014
Insoluble silica.....	62.0454
Combined silica.....	13.0560
Soluble silica.....	.2027
Potash (K_2O).....	.4422
Soda (Na_2O) .....	.9446
Lime (CaO).....	.9300
Magnesia (MgO).....	.3627
Peroxid of iron (Fe_2O_3).....	4.9132
Alumina (Al_2O_3).....	7.8131
Phosphoric acid (P_2O_5) .....	.1919
Sulphuric acid (SO_3).....	.0597
Chlorin.....	.0149
Water at $120^\circ C$	2.4560
Volatile and organic matter.....	7.0400
Total	100.4724
Humus.....	1.0606
Nitrogen .....	.3210

Sample No. 41, sent by John R. Reavis, was taken from the farm of E. H. Morrison, on section 19, township 22, Spokane county.

The analysis of this soil simply confirms what experience has already shown to be true, viz., that this is an exceedingly fertile soil. Not only is it rich in the elements of plant food, but its physical conditions seem to be perfectly adapted to plant development, and the rainfall of the region is ample for agricultural needs. Clay subsoil.

Samples 39, 40 and 41 were analyzed by request, to determine their adaptability to sugar beet culture. Hence we give, in the following table, for the sake of comparison, the analyses of these three soils, two sugar beet soils of Nebraska analyzed by the writer a few years ago, and one beet soil each from France and Russia.

	No. 32.	Norfolk, Neb.	No. 40.	Fremont, Neb.	No. 41.	*France.	†Russia.
Insoluble silica.....	68.2064	57.1863	67.2544	67.5283	62.0454	} 81.8000	72.6990
Combined silica.....	12.4170	16.0350	13.1920	11.9390	13.0560		
Soluble silica.....	.2127	.0707	.3527	.1732	.2027		
Potash (K ₂ O).....	.2748	.8104	.0582	.7867	.4422	.0640	2.047
Soda (Na ₂ O).....	1.2013	.1591	.2916	.1432	.9446	.0850	.914
Lime (CaO).....	.9790	.5673	1.7580	.4355	.9300	.5100	1.930
Magnesia (MgO).....	.0159	.7682	.6477	.2585	.3627		
Peroxid of iron (Fe ₂ O ₃).....	5.4860	3.7427	5.5162	1.3009	4.9132	2.8800	2.834
Alumina (Al ₂ O ₃).....	5.6074	8.0356	6.7589	7.9041	7.8131	7.2400	9.974
Phosphoric acid (P ₂ O ₅).....	.1663	.1199	.1599	.1008	.1919	.0700	.093
Sulphuric acid (SO ₃).....	.0429	.1287	.0551	.0378	.0597		
Chlorin.....	.0083	.0079	.0133	.0181	.0149		
Water at 120° C.....	1.9333	4.2481	1.6667	3.0800	2.4560		
Volatile and organic matter.....	3.1467	7.7425	3.3667	6.4805	7.0400	5.6000	6.207
Totals.....	99.6980	99.6224	101.0914	100.1866	100.4724		
Humus.....	.6898		.5446		1.0606		
Nitrogen.....	.2360		.1670		.3210		

* "Sugar Beet," pp. 103-4.

† "La Bettrave a Sucre," p. 82.

An inspection of this table shows that Nebraska beet soils are much richer in potash than the Washington soils, but contain a lower percentage of both lime and phosphoric acid. The soils from France and Russia are said to produce excellent sugar beets. The former is very deficient in plant food when compared with our own soils, while the one from Russia has unusually large amounts of potash and lime, but is low in phosphoric acid.

Bulletin No. 3 of the United States Weather Bureau gives the analyses of two "dust soils" of the arid region. These are inserted here because of their intrinsic interest, and because they have a direct bearing on some points to be discussed in succeeding pages.

No. 1 was taken from Ahtanum prairie, Yakima county, and No. 2 from near Rattlesnake creek, Kittitas county.

	No. 1.	No. 2.
Insoluble residue.....	76.780	80.530
Insoluble silica.....	71.670	78.330
Combined silica.....	5.110	2.200
Potash (K_2O).....	1.070	.700
Soda (Na_2O).....	.350	.240
Lime CaO).....	2.000	2.080
Magnesia (MgO).....	1.340	1.470
Peroxid of iron (Fe_2O_3).....	6.880	6.130
Alumina (Al_2O_3).....	7.910	6.120
Phosphoric acid (P_2O_5).....	.130	.180
Sulphuric acid (SO_3).....	.020	.020
Water and organic matter.....	2.820	2.350
Total.....	99.290	99.830
Humus.....	4.100	.....

In the bulletin from which these analyses are taken, the following comment is made:

"In their chemical composition these soils are very good illustrations of generalized soils of the arid regions. It will also be noticed that the percentages of mineral plant food in these soils is quite large, and that according to all experience they should be found profusely and permanently productive. This forecast is abundantly confirmed by local experience."

No analyses having been made by us as yet from Southeastern Washington, we have thought it best to insert here the analytical results obtained ten years ago from seven samples from that section of the state, by the chemical division, United States Department of Agriculture, published in Bulletin No. 10.

	No. 1656.	No. 1657.	No. 1658.	No. 1659.	No. 1660.	No. 1661.	No. 1662.
Moisture.....	.525	1.300	1.950	1.600	.675	1.325	1.125
Insoluble silica.....	78.602	62.165	62.640	63.640	71.585	67.575	64.860
Combined silica.....	5.983	17.600	16.485	16.105	11.480	13.925	16.185
Soluble silica.....	.275	.260	.275	.470	.370	.575	.385
Peroxid of iron (Fe_2O_3).....	3.920	4.800	5.248	5.056	4.256	4.736	4.768
Alumina (Al_2O_3).....	4.698	6.738	6.818	5.740	5.328	5.510	6.238
Phosphoric acid (P_2O_5).....	.192	.192	.224	.224	.216	.224	.224
Lime (CaO).....	1.338	1.433	1.329	2.099	1.418	1.428	1.449
Magnesia (MgO).....	.703	.659	.465	1.411	.973	.947	.991
Potash (K_2O).....	.440	.495	.475	.545	.535	.940	.700
Soda (Na_2O).....	1.690	1.560	1.070	.830	.945	1.255	.700
Sulphuric acid (SO_3).....	.043	.052	.060	.069	.052	.035	.129
Chlorin.....	.020	.015	.020	.030	.020	.007	.014
Carbonic acid (CO_2).....	.005	.002	.116	.110	.090	.116	.000
Volatile and organic matter.....	2.045	3.573	3.584	2.040	1.885	1.559	2.600
Totals.....	100.479	100.844	100.759	99.969	99.828	100.157	100.368
Nitrogen.....	.044	.089	.075	.069	.140	.224	.067

The following comments and explanations are taken from the bulletin containing the above tables:

The samples were taken from various points of a section of unsettled country (1885) lying between the Yakima and Columbia rivers, and west of Wallula, on the Northern Pacific Railroad, comprising about 1,300 square miles of gently rolling plateau, from 500 to 1,000 feet above sea level; the only drawback being a lack of running streams of water on any part of it, and but few natural springs. Water is reached at varying depths, from fourteen to eighty feet. The samples were taken from one to five feet in depth, the soil being a decomposed basalt from three to 100 feet deep, and the subsoil being basaltic rock.

No. 1656.—Sandy soil from five miles northeast of Umatilla, Or.

No. 1657.—Surface soil in Grant's ranch, Sec. 24, T. 11, R. 24.

No. 1658.—Two feet of soil in Grant's ranch, Sec. 24, T. 11, R. 25.

No. 1659.—Soil from T. 8, R. 26.

No. 1660.—Soil from Sec. 26, T. 7, R. 26.

No. 1661.—Soil from middle of T. 8, R. 27, between Yakima and Columbia rivers.

No. 1662.—Soil from Sec. 12, T. 8, R. 28.

These samples were taken in 1884, and are samples of virgin soil, and contain a large amount of the most important soil constituents, as phosphoric acid, lime, potash, etc., and should produce abundant crops under favorable climatic conditions. In their content of nitrogen, however, they are, with the exception of Nos. 1660 and 1661, somewhat deficient; and this would indicate that ammoniacal manures would have to be applied in the future, if by excessive cropping the soil should become unproductive.

For convenience of comparison we have classified the soils analyzed by us into three groups: Table I includes all samples from west of the Cascade mountains. Table II embraces all those taken from the irrigated districts of Eastern and Central Washington. Table III includes the soils of the Palouse country.

Table I.

	No. 19.	No. 20.	No. 21.	No. 25.	No. 27.	No. 28.	No. 31.	No. 32.	No. 33.
Insoluble silica.....	70.9610	66.6680	21.6490	68.4150	45.4490	45.0780	43.6196	} 56.9087	74.1593
Combined silica.....	9.6490	9.1870	6.7030	10.6460	15.0420	18.9760	14.3732		
Soluble silica.....	.4200	.0330	.1808	.9850	.0253	.0430	.2750	.0155	.2105
Potash (K ₂ O).....	.2022	.0077	.1366	.5908	.0154	.2770	.6505	.0126	.0474
Soda (Na ₂ O).....	.2785	.2865	.1910	.0584	.4643	.4377	1.0763	.9338	.2361
Lime (CaO).....	.6550	.7690	.3790	.3625	.1090	.0828	.4315	.1303	.3980
Magnesia (MgO).....	trace.	.4261	.0361	.2810	.0226	.0658	.0334	.0334	.0182
Peroxid of iron (Fe ₂ O ₃).....	4.5351	3.5870	1.0550	6.4625	6.0888	6.4807	9.7362	3.1047	5.1524
Alumina (Al ₂ O ₃).....	7.1591	6.4646	4.3012	7.2316	9.4315	9.4547	13.8841	8.4270	7.8630
Phosphoric acid (P ₂ O ₅).....	.0384	.0544	.3135	.3535	.1407	.3006	.5438	.3118	.3998
Sulphuric acid (SO ₃).....	trace.	.0384	.0934	trace.	.0079	.0247	.0258	.0090	trace.
Chlorin.....	.0029	.0066	.0183	.0179	.0149	.0099	.0249	.0199	.0199
Water at 120° C.....	1.7773	3.1200	11.7600	1.8534	12.8533	9.6800	5.9200	7.3200	3.6267
Volatile and organic matter.....	4.5651	9.1600	52.8739	2.7341	10.4267	8.6933	10.2400	23.1733	7.8667
Totals.....	100.2436	99.8083	99.6908	99.9917	100.0914	99.6042	100.8343	100.0000	100.0000
Humus.....	1.8960	2.0010	6.9154	.3551	.4227	.1910	2.2064	3.9797	1.9435
Nitrogen.....	.1023	.2345	1.3466	.1780	.2321	.0463	.5211	1.1290	.3729

Nos. 19, 20, 21 and 33, from Skagit county; Nos. 25, 31 and 32, from Clarke county; Nos. 27 and 28, from Pacific county.

An inspection of this table shows that with the exceptions of Nos. 25 and 31, the potash percentages are quite low, and that in all cases, except No. 25, is below the percentage of soda. This is a somewhat unusual circumstance, and at present we have no explanation to offer to account for it.

Nos. 19 and 20 are the only ones in which lime is present in satisfactory amounts, and these two come from a section of low rainfall as compared to the other localities represented in this table. The percentages of phosphoric acid are unusually high, except in Nos. 19 and 20. The amounts of iron vary from 1 to 9½ per cent. The nitrogen content is satisfactory in all, but rather low in No. 28.

Table II.

	No. 17.	No. 39.	No. 40.
Insoluble residue	78.4340	80.6234	80.4464
Insoluble silica.....	60.2070	68.2064	67.2544
Combined silica.....	18.2270	12.4170	13.1920
Soluble silica.....	.2100	.2127	.3527
Potash (K_2O).....	.4328	.2748	.0582
Soda (Na_2O).....	.3729	1.2013	.2916
Lime (CaO).....	1.2127	.9790	1.7580
Magnesia (MgO).....	.7880	.0159	.6477
Peroxid of iron (Fe_2O_3).....	5.1586	5.4860	5.5162
Alumina (Al_2O_3).....	6.8906	5.6074	6.7589
Phosphoric acid (P_2O_5).....	.1007	.1663	.1599
Sulphuric acid (SO_3).....	trace.	.0429	.0551
Chlorin.....	.0058	.0083	.0133
Water at 120° C.....	3.4527	1.9333	1.6667
Volatile and organic matter.....	3.0195	3.1467	3.3667
Total.....	100.0793	99.6980	101.0914
Humus.....	.2550	.6898	.5446
Nitrogen.....	.0876	.2360	.1670

No. 17, from Yakima county; Nos. 39 and 40, from Adams county.

This table shows a low percentage of potash in 39 and 40. All three samples contain large amounts of lime, and a high proportion of phosphoric acid. It is also to be noted that the ratio between the percentages of iron and alumina is nearly the same in each soil. This is probably a mere coincidence. In Nos. 39 and 40, as with the Western Washington samples, the soda is in excess of the potash.

The amount of insoluble matter is nearly constant.

Table III.

	No. 5.	No. 11.	No. 16.	No. 29.	No. 41.
Insoluble residue.....	76.4944	78.7114	77.7110	69.6529	75.1014
Insoluble silica.....	62.8314	65.7684	60.6690	69.6529	62.0454
Combined silica.....	13.6630	12.9430	17.0420		
Soluble silica.....	.3010	.0156	.4650	.0220	.2027
Potash (K_2O).....	.6351	.3315	.5308	.4486	.4422
Soda (Na_2O).....	.3739	.5687	.3236	.5041	.9446
Lime (CaO).....	1.0814	1.5125	1.1800	.7810	.9300
Magnesia (MgO).....	.7277	1.5274	.7339	.1228	.3627
Peroxid of iron (Fe_2O_3).....	4.5539	4.6101	4.2705	4.8229	4.9132
Alumina (Al_2O_3).....	7.5263	5.9300	6.3703	8.1376	7.8131
Phosphoric acid (P_2O_5).....	.1423	.1823	.1392	.3455	.1919
Sulphuric acid (SO_3).....	trace.	trace.	trace.	.0494	.0597
Chlorin.....	.0204	.0152	.0048	.0066	.0149
Water at 120° C.....	4.5234	2.7313	2.6341	3.4933	2.4560
Volatile and organic matter...	3.6124	3.7452	5.5002	11.6133	7.0400
Total.....	99.9922	99.8812	99.8634	100.0000	100.4724
Humus.....	.9950	.6100	1.2211	3.4655	1.0606
Nitrogen.....	.1096	.1409	.1120	.7203	.3210

Nos. 5, 11 and 16, from Whitman county. Nos. 29 and 41, from Spokane county.

The soils of this table all show strong percentages of potash, lime and phosphoric acid. Three of them have more soda than potash.

These tables furnish us with some interesting facts which may or may not be of special importance.

We give below the maximum, minimum and average percentages of lime, phosphoric acid and potash, found in Eastern and Western Washington soils.

	Eastern.			Western.		
	Maxi- mum.	Mini- mum.	Aver- age.	Maxi- mum.	Mini- mum.	Aver- age.
Potash (K_2O).....	.6351	.0582	.3943	.6505	.0126	.2156
Phosphoric acid (P_2O_5).....	.3455	.1007	.1785	.5438	.0384	.2730
Lime (CaO).....	1.7580	.9300	1.1793	.7690	.0828	.3686

This shows the soils of Western Washington to have a higher average per cent. of phosphoric acid, but lower average of potash and lime, than those of Eastern Washington. Hence the former will wear out sooner on the side of lime and potash.

Results of a large number of analyses have shown almost conclu-

sively that soils in a region of abundant rainfall contain less lime than those in arid regions; provided, of course, that neither are underlain by or in the vicinity of limestone formations. This fact is well verified in case of our soils east and west of the Cascade mountains; the average lime content of the former being three times that of the latter. This is specially significant in view of the fact that nearly all the soils of Eastern Washington are derived directly from black basaltic rocks.

With the samples analyzed so far, it seems almost as if the lime percentages are inversely proportional to the amount of annual rainfall.

For example we find the following relations:

<i>Lime percentages.</i>	<i>Annual rainfall.</i>
1.2127 } .9790 } 1.7580 }	.....about 8 inches.
1.0814 } 1.1800 } .7810 }	.....20 to 22 inches.
.9300 } .6550 } .7690 }	.....24 inches.
.3625 } .4315 } .1303 }	.....48 inches.
.1090 } .0828 }	.....76 inches.

It will be interesting to note whether future analyses will reveal this same relation between the rainfall and the lime content of our soils.

All of the Washington soils thus far analyzed, except one, are unusually high in phosphoric acid. It is easy to account for this fact in portions of the state where the soil has been derived from basaltic rocks. Basalt frequently contains small crystals of apatite, which are mainly calcium phosphate. This substance is quite insoluble, but the chemical and mechanical processes that contributed to soil formations have, without doubt, furnished an abundance of the finely pulverized mineral available for the use of plants. The basaltic soils wherever found are highly productive. They are the characteristic soils of Italy and other places bordering on the Mediterranean. In Washington they have produced wonderful grain crops for many years without apparent exhaustion. It is probable that when their productiveness declines, potash, and *not* phosphoric acid, will be needed.

We are not yet prepared to advance any theory to account for

the very high proportions of phosphoric acid in the soils of Western Washington. More data are needed from other analyses.

CONCLUSION.

As said at the beginning, this is only put forth as a preliminary bulletin, hence is not complete. It is the first of a series of bulletins that will be issued as the work of a state soil survey progresses. This work will necessarily be slow, but will be pushed as rapidly as possible, consistent with thoroughness and accuracy.

We summarize the preceding pages as follows:

(1) Soils are derived from original rock masses, and partake of the characters of the rocks.

(2) They are enriched by the products of decomposition of vegetable matter.

(3) The mineral plant food derived from the rocks consists of about twelve substances.

(4) Of these substances only three, viz., lime, potash and phosphoric acid, must be restored to the soil to maintain or increase fertility.

(5) Barrenness may be due — (1) To a deficiency in these three substances; or (2) to their not being in an available form; or (3) to adverse climatic conditions.

(6) Chemical analysis can reveal deficiencies in plant food and give percentage composition, but cannot show the availability of the constituents to the use of the plant.

(7) Chemical analysis, supplemented by mechanical analysis, by geological facts, by cultivation experience and by meteorological data, may yield great service to agriculture and horticulture.

(8) Analytical results prove that Western Washington soils will be greatly strengthened by the application of lime.

(9) The average percentages of lime and potash are higher and phosphoric acid lower in Eastern than in Western Washington.

(10) The lime percentages are lower in regions of abundant rainfall than in the drier portions of the state.

(11) The objective point of this work on soils is a complete soil survey of the state, which will be carried on as rapidly as possible.

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SCHOOL OF SCIENCE.

EXPERIMENT STATION,
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BULLETIN 14.

(All Bulletins of this Station are sent free to citizens of the State on application to the Director.)

DEPARTMENT OF AGRICULTURE.

SILOS AND ENSILAGE.

By W. J. Spillman.

NOVEMBER, 1894.

THE AGRICULTURAL EXPERIMENT STATION.

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PREFACE.

So much has been accomplished by the experiment stations during the few years of their existence, that it now seems a duty every station owes its constituency to compile the facts so far learned for the benefit of farmers who do not have access to the bulletins issued by stations in other states. The present bulletin is mainly such a compilation.

Since stock raising has already become an important feature of the agriculture of this state, and dairying is rapidly becoming one of our leading industries, it is probable that many farmers in the state will, in the near future, desire to construct silos. This being the case, it is the duty of the experiment station to give them the benefit of the twenty years of experience with silos in this country. It is with this object in view that this bulletin is issued. As silos are little known in the state, it is assumed that elementary facts about the subject in hand will be appreciated by many who read this.

Acknowledgments are due to Prof. F. H. King, of the Wisconsin station, for the use of cuts 3 and 4.

SILOS AND ENSILAGE.

W. J. SPILLMAN.

A silo is a box, bin, or pit in which fodder may be preserved in its green state. Fodder thus preserved is silage, or ensilage. In order to keep fodder green, all that is necessary is to keep the air from getting to it. The process of making silage is therefore based on the same principle that canning fruit is. The object of making silage is to have green fodder in winter and in the dry part of the summer season, when stock would otherwise be compelled to subsist entirely on dry feed.

Fodder is usually run through some kind of cutting machine before it is put into the silo, for several reasons: It is easier to handle in getting it out of the silo; it is more thoroughly mixed up so that stock will eat all parts of the plant; and in taking it out of the silo it enables one to rake off the whole top layer every day, which is an important item, as will appear further on.

Changes That Take Place in Fodder in the Silo.

When fodder is cut up and dropped into the silo there is always some air left in the little spaces between the pieces. This makes it possible for the little organisms that cause changes in animal and vegetable matter to live for a few days in the fodder, and to cause certain changes to take place in its composition. (If air can enter through holes in the wall, these little organisms continue to live and produce changes till all the silage near the air hole has completely rotted.)

The changes produced by these microbes are not always the same, because there are many kinds of microbes that may be present. But they usually result in the production of a small amount of acids, thus imparting to the silage more or less of a sour taste. For this reason stock do not usually relish ensilage at first; but if it be gradually introduced into their feed they become very fond of it. When well made, of good material, it is an excellent feed for part of the ration of stock, especially dairy cows.

Ensilage as a Stock Feed.

There is no longer any doubt that ensilage is one of the best feed stuffs for cattle, taking the place of hay. A cow will ordinarily eat about one cubic foot, or forty pounds, of it per day, along with her grain ration. It has proven excellent for horses when fed in place of half the regular hay ration; that is, about twenty pounds a day. It has been fed to sheep and hogs quite successfully by some, but it has never been a popular feed for them. Poultrymen recommend it very highly for chickens.

Ensilage seems to sharpen the appetite of an animal and to aid in digesting other food. It also tends to keep the bowels in good condition.

Crops Suitable for Silage.

The universal testimony of those who have tried various kinds of ensilage is, that common Indian corn is the best suited for it, where that can be raised; and there is yet to be discovered a part of the United States in which corn fails to grow enough to make fairly good silage. Other crops have been successfully used for ensilage, the principal of which have been clover and sorghum. In the south the cow pea is extensively used. Alfalfa has been used; also rye. As to the varieties of corn best to use it may be said that any variety that will mature in the given locality will make good ensilage. It is not even necessary that the corn mature, but it makes better feed when it can be obtained just about the time the grain begins to become firm. The experiment station is not yet in a position to recommend any particular varieties, but will be, it is hoped, another year. Some twenty-five varieties will be grown on the college farm next season, and the results made public as soon as possible. We hope also to be able to give advice as to time of planting, manner of seeding and cultivation, etc. Farmers who are desirous of experimenting with varieties of corn next season would do well to try the following: Stowell's Evergreen, Minnesota Dent, Leaming, Sibley's Pride of the North, Southern Ensilage Corn and Southern Horse Tooth. As it is a matter of some difficulty to keep varieties of corn from mixing, it is usually not possible to obtain pure seed without dealing with men who make seed raising a specialty; hence it is recommended that those desiring seed corn correspond with the regular seed men, whose advertisements may be found in any leading agricultural paper. If it can be done, it

pays to get seed raised in this climate, as you may then have some assurance that the corn will mature sufficiently to make good silage.

How to Grow Corn for Ensilage.

The best way is to plant it just as you would for fodder or for the grain. If planted in rows both ways and cultivated well it will make more and better feed than when sown broadcast and given no cultivation. One object of raising corn is to get rid of noxious weeds, and this can best be done by giving the ground such cultivation as to induce the weeds to grow and then keep them from growing by killing them as soon as they make their appearance. In cultivating corn remember the following well established facts: Keep the soil well stirred near the surface. Do not cultivate more than two or three inches deep after the corn is six inches high. Keep free from weeds till it is too late for weeds to mature seed. The first two cultivations before the corn is more than four inches high may be given with a drag tooth harrow.

Putting Silage Into the Silo.

Crops to be used for silage should be cut, as a rule, just at the time when the plant has begun to mature and before its tissues have begun to get dry and hard. Forage plants generally make more and better feed at this stage than at any other. Unusually coarse plants should be cut a little earlier; tender plants may be cut later. The plants from which it is desired to make silage may be harvested and brought in immediately to the ensilage cutter, cut up and poured into the silo; or they may be allowed to lie in the field a day and become wilted. Pea vines do better when allowed to wilt, and thus get rid of part of the large amount of moisture they contain.

The silo may be filled as rapidly as possible, or it may be filled slowly. Several days may intervene at any time in the operation without serious consequences. It is best to cut the silage into small pieces to make it pack down better, and to aid in removing it from the silo. Half to three-quarters of an inch is a good length to cut it. It must be well packed down in the silo, and to accomplish this it is the best plan to have a man in the silo while it is being filled. He should be careful to see that the silage is well packed around the corners and sides, for it is there that air is most likely to get to it and spoil it.

How to Cover the Silage to Render it Air Tight.

More questions have been asked me on this point than on any other relating to the subject. It is not absolutely necessary to cover the silage at all. Of course, when no covering is put on, there will certainly be a few inches of spoiled silage at the top. This layer of spoiled silage acts as a sort of cover to that below, preventing the air from penetrating to any great depth. But if it is desired to prevent this spoiling even of the top layer, it may be done quite successfully by putting on a layer of boards, then a layer of tarred paper, then another layer of boards. It used to be thought that it is necessary to weight the silage down, but this practice has been largely abandoned. All except the top is already weighted with the weight of that above it. Some recommend wetting the top of the silage when the silo is full. This helps to form a mold that protects the silage.

Precautions in Taking Silage Out of the Silo.

One may begin feeding silage as soon as the silo is filled, or it may be kept for several weeks or months. This much must be remembered, however, in taking it out: freshly uncovered silage will spoil in a short time if left exposed to the air. In order to prevent the silage from spoiling as it is being fed, it is therefore necessary to feed off the whole top surface every day. This is the reason for constructing silos that are very tall; we thus have a small surface from which we can remove the entire surface in the ordinary course of the day's feeding. This leads us naturally to the

Form of the Silo.

A silo should be built of such form that in feeding out the silage at least two inches of silage shall be removed from the whole exposed surface every day. Experience has demonstrated that a depth of less than twenty or twenty-four feet is not advisable, and thirty to thirty-six feet is better. Ensilage packs down and keeps better in a deep silo than in a shallow one. Its other dimensions must be governed by the amount of stock to be fed from it. A cow, given proper quantities of other food, will eat approximately a cubic foot of ensilage per day. And as two inches of silage should be removed from the silo a day, we may estimate six square feet to each cow as the largest surface we can safely give the silage. When the number of stock to be fed is small, we can remedy the

difficulty by putting partitions in our silo and feeding out one side at a time. It should be remembered that a large silo is cheaper than a small one when we take into account the difference of their holding capacities. A farmer having twenty head of stock (cows and horses) to feed should partition his silo off into compartments not larger than 120 square feet floor area. Sheep and hogs eat much less, and hence three or four should be reckoned as one.

Silos were formerly built of a rectangular pattern, but it is now known that a round silo is less difficult to construct, and is cheaper. The principal difficulty in the construction of a silo is to build a wall that will not bend under the pressure of the silage, and thus open up small crevices at the corners. Round silos do not present this difficulty. A round silo may have 2x4 studding, the circular lining holding the walls from giving way. The walls of a rectangular silo, however, must be very strong; the studding for a rectangular silo 20 feet high should be 2x10. If it be higher the studding should be 2x12. Fig. 2 shows how the corners of a silo may be constructed so that there will be little danger from crevices at that point.

Location of the Silo.

Ensilage is heavy material, hence the silo should be located near the place where it is to be fed. When the stock are arranged on two sides of an alley, it is quite convenient to have the door of the silo at one end of the alley.

The cost of the silo will be considerably smaller if there is room for it inside the barn. It is not then necessary to put any kind of siding on the outside of the studding of the silo, and no roof will be needed. But if the barn has not the room in it, the silo is best located near one side of the barn, so that by cutting a door through the barn wall you have a door to your silo. Do not place the silo as a leanto; that is, do not make the wall of the barn serve as one side of the silo. You will have endless trouble in construction if you do; and when it is done the pressure of the ensilage will tend to open a crevice where the silo joins the barn. Build the silo just as if it stood out by itself, except that you need not put any siding on the side that is against the barn. A silo built as a leanto costs more than one built as if it were not near any other structure.

Comparative Merits of Wooden, Stone and Metal Silos.

The early silos were usually holes in the ground lined with stone and mortar. For convenience in getting the silage out of the silo

it soon became the practice to build them partly above ground; and it being much more convenient to line this upper portion with wood, it was soon discovered that the silage kept as well in contact with wood as with the cement and stone. The silo then emerged from under ground, and is now nearly always, at least in this country, built wholly above ground. It also came to be recognized that since a wooden silo keeps the silage as well as one of stone, and since the wooden one is much cheaper, a stone silo is an expensive luxury. There are very few stone silos in this country. A few farmers in the extreme northern states have built them with the idea of protecting the silage from freezing, which is an important item; but it is probably as easy to accomplish this with a wooden wall as with a wall of stone. If the inner lining of the silo be made of two layers of boards with tarred paper between them, and the siding without be nailed to sheeting with a layer of building paper between the siding and the sheeting, there will not be any danger in this climate from freezing.

Furthermore, it has been learned that the juices that are found in the ensilage attack the cement of a stone silo, gradually eating it away. The same is true of metal linings; they cannot withstand the chemical action of the acids of the silage juices. Even if they be heavily painted, the paint will get scratched off in places, leaving the metal exposed.

It is pretty well settled, then, that wooden silos are, in the long run, the best, as well as the most economical.

The Difficulty With Wooden Silos, and How to Overcome It.

The one difficulty with wooden silos is the rotting of the wood. It has already been stated that decay and change in animal and vegetable matter is due to the growth of small organisms in the decaying or changing substance; the organisms that cause the rotting of wood thrive best in wood that is moderately moist. They do not develop in wood that is very dry or very wet. Now the silage contains a great deal of water which, in the lower part of the mass, presses out and is absorbed by the wooden walls. The object sought, then, is so to construct the walls that as little as possible of the wood will become wet, and so as to allow that which must get wet to get thoroughly wet in a short time, and to dry out again as readily when the silage is removed. These may all be accomplished by constructing the lining of the silo of two layers

of boards with a layer of tarred paper between the layers, each layer of boards being heavily tarred on the side that lies against the paper. The first layer may have the tar applied after the boards are nailed on; the boards of the second layer must have the tar applied to them in time for it to dry before they are put on. The tar used should be coal tar, boiled till it is not sticky when cold, and it should be applied hot.

With the lining constructed as here indicated, and with proper ventilation between the siding and the lining, there is little danger from rotting of the wood in the walls. How to secure this ventilation, as well as how to prevent rotting of the lining where it touches the sills, will be explained under "Sils for Rectangular Silos."

The Foundation.

This should consist of stone or brick, laid in mortar, and should be about eight inches high. When ready to lay the sills, cover the foundation wall with cement and lay the sills in this. The sills should first have their lower side and the side next the lining covered with coal tar. The top and outer side of the sills should not be covered with tar, for it would prevent their drying out when moisture soaks into them, as it is almost sure to do to some extent. The inner side of the foundation wall should also be lined with cement, but this should not be done till the lining is on, so that the cement may be put on flush with the boards of the lining. (See Figs. 3 and 4.)

The Floor.

It is not absolutely necessary to have a floor in a silo. But when there is no floor there is danger from the depredations of rats and mice. There is also less difficulty in preserving the ensilage at the bottom of the silo when it has a good floor under it. In making a silo floor, first smooth down the ground and pack it well with a maul or something of the kind. Then cover the ground about three or four inches deep with cement, made by either of the following methods:

First. American hydraulic cement, one part; sand, two parts; broken stone (not over two inches in diameter), three parts.

Second. Portland cement, one part; sand, three parts; broken stone, five to seven parts.

Third. Portland cement, one part; sand, two and one-half parts; gravel, three parts; broken stone, five parts.

MIXING THE CEMENT.—Take about half the sand to be used and spread it evenly in the mortar box; sprinkle the cement over it; then add the remainder of the sand. Mix thoroughly with a hoe. It is important that the mixing be well done. Next, wet the mass and stir the water in well. The amount of water used depends on the kind of cement used; Portland cement requires a little less than half as much water as the weight of the cement added. Other cements require a little more than half as much water as cement. After this is accomplished, add the broken stone and mix it up thoroughly with the mortar. The broken stone should be thoroughly wetted before being added, to prevent it from absorbing moisture from the mortar. Especially is this the case if the broken stone be brickbats or other porous material.

The floor should not be put in till the silo is completed, as it would require a day or two to set, and there would be danger of breaking the floor by letting heavy timbers fall on it.

In laying the floor spread the mortar evenly over the ground and pack it down with a maul or pestle.

The surface of the floor should be about two inches higher than the ground without.

The cement for lining the inside of the foundation wall, and in which to lay the sills, may be made by mixing one part cement, one part quick lime, and four parts sand. Add sufficient water to make a mortar of good workable consistency.

Construction of a Round Silo.

Having decided on a round silo, and having the foundation made accordingly, the next thing to consider is the sills. These may be made of 2x4 scantling, cut into lengths to correspond to the distance between the studding. This distance should be about one foot. These short pieces should be cut on a radius of the silo, so that the edges that come together will match. That is, the line of contact between each two pieces of the sill should point toward the center of the silo. The studding should then be placed in the center of each of these pieces, so that the lining will not be in contact with the sill except at the center of each piece of the sill. These pieces should be firmly spiked together, and the whole laid in cement mortar, and, as before stated, the sills should have a coat of coal tar applied to the under and the inner sides.

STUDDING.—The studding may be of 2x4 scantling placed one foot apart. It is not necessary to get studding as long as the silo is high; short lengths may be spliced. For a silo thirty feet high sixteen foot pieces and fourteen foot pieces may be spliced together. The plates may be made similar to the sills, except that the joints should come at the studding instead of between them.

LINING.—The boards used for lining in a circular silo should be not more than one-half inch thick, because they must be bent in putting on. They may be rabbeted like ordinary shiplap, but not tongued and grooved. Common inch fencing lumber split into half inch boards makes very good lining. It is not necessary, though it is desirable, to have the boards rabbeted. After the first layer of the lining is on a good coat of coal tar, boiled till it is not sticky when cold, should be applied to it. A layer of tarred paper should then be tacked to the tarred boards. This paper should then be covered with another layer of boards that have been tarred on the side that goes against the paper. A good method of tarring these boards is to lay them across the tar vat as it stands on the fire, and as one man draws the board across another applies the hot tar with an ordinary broom. All the tar used in constructing a silo should be applied hot in order that it may soak into the pores of the wood better.

The lining should not be carried clear up to the plate; a space of a few inches should be left to allow of ventilation between the lining and the siding.

Care should be taken to see that the two layers of the lining break joints, as otherwise there might be air holes left that would spoil a lot of silage.

SIDING.—If the silo is built inside another building no siding will be necessary; but if it is not in another building it may be sided up as any other building would be. In many of the northern states where the cold is extreme, silos are usually sheeted outside as for shingling, and then a layer of building paper and a layer of siding nailed to this. This protects the silage from freezing. Freezing does not hurt silage particularly, but it makes it awkward to get out of the silo sometimes, and might also injure the silo by the expanding of the ice as it forms.

ROOF.—An ordinary roof is all that is required. If the silo is inside the barn no covering is needed. If the silo is outside, and

it thus becomes necessary to cover it with a roof, a ventilator should be put in the roof. This will aid the ventilation between the siding and lining, and will help the silo to dry out when the silage is removed. Either a ridge or a round roof may be put on a round silo. The round roof will probably require less mechanical ingenuity to construct.

The following directions for roofing a round silo are taken from the annual report of the Wisconsin station:

“No rafters are required for silos eighteen feet or less in diameter. For the roof of small silos a circle may be sawed out of 2x8s, and the pieces spiked together in two layers, the pieces breaking joints, and it should have an outside diameter of five to seven feet, according to the size of the silo. With this type of roof the roof boards may be cut the length which would be required for rafters, and then sawed diagonally from corner to corner, leaving the two ends of such widths as will correspond to the size of the two circles made by the opposite ends, and this should be done at the mill. The circular frame is supported in place and the roof boards nailed directly to it and to the plate, when the whole becomes self-supporting.”

Larger silos may be roofed in the same way by using two or three circles. These boards may then be covered with ordinary shingles.

WINDOWS FOR FILLING THE SILO.—A window should be left near the top of the silo, in a convenient place for putting in the silage. Be careful to get it large enough to admit the carrier that takes the silage from the cutter into the silo. If desired, another window may be made lower down, through which the lower part of the silo may be filled.

DOORS.—Some silos have a narrow door extending from top to bottom. Others have a door at the bottom with a chute extending up from it to the top, where there is another door for one to enter in getting out the silage. The chute is made as follows:

To pieces of 2x8 or 2x10 are nailed to the inside of the silo wall before the second layer of the wall is put on, one on either side of the door, and extending from top to bottom of the silo. Boards are nailed to these so as to project about two inches beyond their edges, as shown in Fig. 1. As the silo is filled, the boards forming the wall of the chute next the silage are laid in in two

layers, with a layer of tarred paper between them. As the silage is removed in feeding, these boards are taken out. The paper between them should be in rather small pieces, in order that it may not be in the way in taking out the silage.

In removing silage from the silo, it must be remembered that any of it left exposed to the air for a few days begins to decompose. It is therefore necessary to feed off the whole top layer every day to a

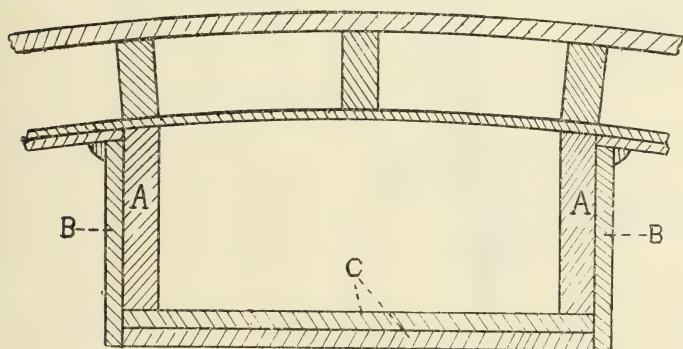


FIG. 1.—Silage chute. *a, a*, Timbers, 2x8 or 2x10, spiked to inside of wall before second layer of lining is put on. *b, b*, Inch boards nailed to *a, a*, and projecting beyond them. *c, c*, Two layers of boards with tarred paper between, laid in loosely. They are held in place only by the pressure of the silage.

depth of at least two inches, and as much deeper as your stock need.

The silage to be fed is raked up with a fork and dropped into the chute, falling to the door below, where it is taken to the feed troughs.

If the door be made to extend from the top to the bottom, it may be made just as described above, being dropped in against two studding, instead of against the chute timbers. In this case boards should be nailed across the door every few feet, on the *outside* of the silo, to prevent the pressure of the silage from spreading the door. In case the chute is used, it is necessary to provide some means of climbing down into the silo and out again. Thick boards beveled on the upper side and tacked to the wall on the inside near the chute serve this purpose very well.

Construction of Rectangular Silo.

The construction of a rectangular silo differs from that of a circular one in the following particulars:

In the rectangular silo the studding must be strong enough to support the pressure of the ensilage without bending to any appreciable extent.

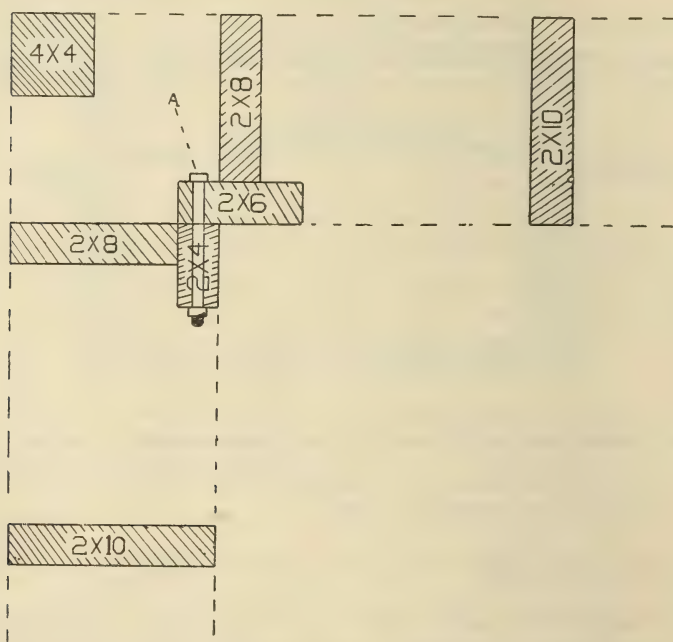


FIG. 2.—Showing cross section of the studding at the corner of a rectangular silo. Half inch bolts (*a*) should be used to hold the 2 x 4 and 2 x 6 together. These bolts should not be more than 18 inches apart from the bottom up to about the middle of the studding. Above the middle they may be two feet apart; they may be reinforced by thirty penny wire spikes.

The corners must be constructed with especial care to prevent formation of crevices and consequent rotting of silage at those points.

The sills must be strong.

The lining should be made of inch boards rather than half-inch.

STUDDING.—The studding for a rectangular silo 20 feet high should be 2x10, 20 feet long, not more than 16 inches apart (on

centers). 2x12 should be used if the silo is to be 24 to 30 feet high.

SILLS FOR RECTANGULAR SILO.—The sills should be two inches narrower than the studding, and should be flush with the outside. This will leave a two inch space between the sill and the lining. The studding should be cut so as to project downward to the lower edge of the sill. The sills may be made of two pieces of two inch stuff spiked together, and cut at the ends so as to lap. If the silo is a large one, it is necessary to build in some iron rods into the foundation wall, letting them project through the sills; this will prevent the great pressure of the ensilage from bending the sills. Make them of three-quarter iron, and let them be about four feet apart.

After the lining is put on, fill the two inch space between the sill and the lining about half full of a mixture of gravel and coal tar, boiled till hard when cold (see Fig. 3). This will help to prevent rotting of the sill and the lining at this point.

CORNERS.—It is quite difficult to construct the corners of a silo so as to exclude the air. The great pressure of the silage tends to spread the corners. This may be prevented by arranging the studding at the corners as shown in Fig. 2.

Ventilation Between Lining and Siding.

Directions have already been given in connection with putting on the lining for leaving a space of a few inches at the top. To complete the means of ventilation bore a large auger hole through the siding between each two studding near the sill. These holes should be covered with wire gauze to prevent vermin from getting in. The space on the inside at the top should likewise be thus covered, to prevent silage from dropping in when filling the silo. If the lining is put on before the siding, the holes should be bored in the first board of the siding before it is put on, so that the wire gauze may be nailed over the inner side of the holes. It will thus be out of the way and will not be so liable to be knocked off. There should also be a ventilator in the roof of the silo to aid in the circulation of the air. The object of this ventilation is to keep the boards dry, so that they will not rot. In very cold weather, when there would be danger of the silage freezing, the ventilating holes should be stopped.

Cost of a Silo.

A good silo costs less than barn room to store the same weight of hay would cost. And as silage is equal to hay in feeding value, and much more of it can be produced to the acre, it follows that silage is a much more economical feed than hay. Prof. King, of the Wisconsin station, thinks that the time will come when we shall feed our dairy cows silage the year round, in preference to pasturing them, for it can be made more economical to do so, turning them out in the meadow after their feed of silage has been eaten to allow them to take exercise and to distribute the manure over the meadow.

The cost of a silo per ton of capacity varies with the capacity. The cost does not increase as rapidly as the size. A 100-ton silo should cost about \$2 to \$2.50 per ton capacity. A 400-ton silo should cost about \$1 to \$1.50 per ton capacity. It is therefore cheaper to build a large silo, if you have feed enough to fill it and stock enough to eat the feed.

Partitions in Silos.

As already stated, the floor area of a silo should not exceed six square feet to each animal to be fed from it, so that in feeding it off no silage need be left exposed to the air for more than a day. If it is desired to feed a small number of animals from a large silo, it may be conveniently done by dividing the silo into compartments of any size desired, by means of partitions put in after the silo is finished. These partitions may be made by putting in 2x4 scantling fifteen inches apart, with a layer of tarred paper and a layer of boards on each side. As the silage is removed from one side, braces must be put in extending from the partition to the opposite wall to keep the partition from giving way under the pressure of the ensilage in the other compartment.

There need be no fear of leaving a silo full of silage as long as may be necessary. Silos have been opened two years after they were filled, and the silage was apparently as good as it ever was. Of course there is apt to be some silage rotten, especially at the top, and at the corners unless these be well constructed. But even if ten per cent. of it spoils, it is still cheaper feed than hay. If the silage be well packed down as the silo is filled, and the top be covered well with a layer of tarred paper between two layers of boards, or even if the silage have no covering at all and be kept

wet by pouring water upon it, the loss will be only an inch or two of the material at the top of the mass.

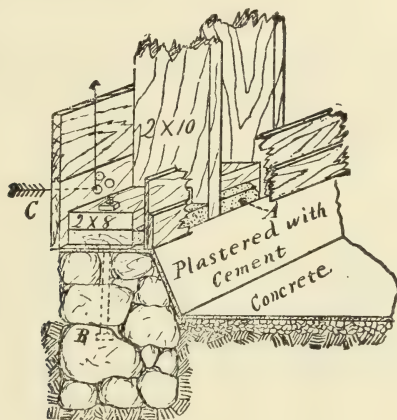


FIG. 3.—Showing the construction and ventilation of the walls of a rectangular silo. The sills are two inches narrower than the studding to leave air space between sills and lining. *A* is two inches of mortar, made by stirring sand into coal tar, boiled until it is hard when cold. *B* is a bolt anchoring the sill to the foundation. These bolts should be placed about four feet apart. *C*, ventilator between the studding.

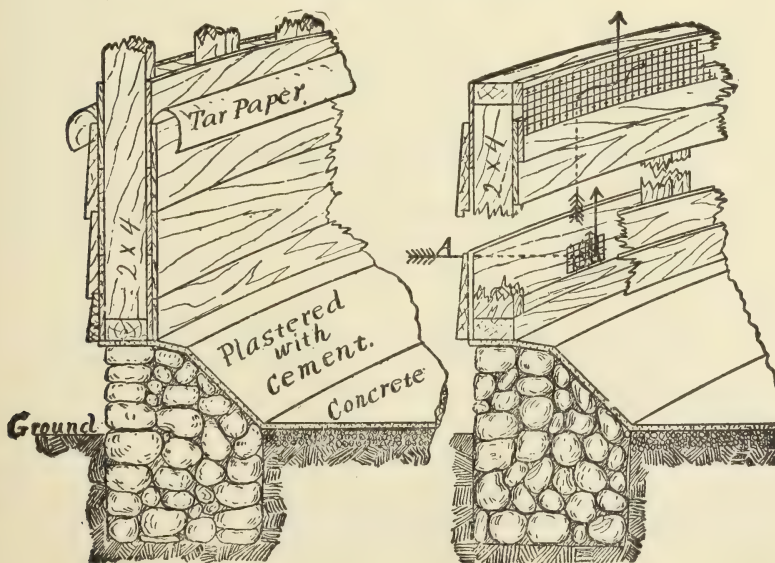


FIG. 4.—Showing construction of round silo. Sills, 2x4, cut into sections, toe-nailed together, and bedded in mortar. Plates, the same, spiked to top of studding. Studding, 2x4, one foot apart. *A* shows ventilator between the studding. Auger holes are bored at bottom between studding, and the boards lack a few inches of reaching plate at top inside. Both sets of openings are covered with wire screens.

Jan. 21, 1896.

WASHINGTON STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 15.

DEPARTMENT OF CHEMISTRY.

SUGAR BEETS IN WASHINGTON.

By Elton Fulmer, A. M.

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Persons desiring their names on our mailing list should address,

PRESIDENT AGRICULTURAL COLLEGE,
PULLMAN, WASHINGTON.

SUGAR BEETS IN WASHINGTON.

BY ELTON FULMER, A. M.

The work detailed in the following pages was undertaken for the purpose of obtaining some definite information concerning the adaptability of Washington soil and climatic conditions to the production of sugar beets suitable for use in manufacturing sugar. This question has been agitated in different sections of the state for several years, and a considerable unorganized experimental work has been performed. Because of the lack of general organization, and because of uncertain conditions attending much of the work, the results obtained previous to last year have been of little practical value to the state at large.

The agricultural conditions that have prevailed in the state during the past two years have also furnished an incentive to this work, inasmuch as they seemed to demand experimentation along lines that would aid in bringing about a greater diversity in farming. Experience in this and other countries has shown very conclusively the superior value of the sugar beet as a factor of diversified farming. Knowing something of the wholesome effects of sugar beets in a crop rotation, and of the stimulation of other industries resulting from the establishment of factories for the manufacture of sugar from beets, the present seemed a very opportune time to begin a work that should demonstrate what we may expect in the future from an industry that has wrought such salutary results in other places.

All of the work carried on in this state previous to 1894 in connection with the sugar beet was under the direction of the United States department of agriculture. From the bulletins of the division of chemistry, published by Dr. H. W. Wiley, we glean the following facts concerning the sample beets sent to him from our state for analysis: In 1890, one sample from Lewis county, which showed 16 per cent. sugar and 84.2 purity. In 1891, eleven samples from Lewis, Snohomish, Spokane, Stevens, Whatcom and Whitman coun-

ties, which gave averages as follows: Weight 18 ounces, sugar 15.2 per cent., purity 83.9. In 1892, fourteen samples from Douglas, Spokane, Stevens and Whitman counties: Average weight 18 ounces, sugar 15.2 per cent., purity 76.8. In 1893, 153 analyses from Asotin, Columbia, Douglas, Kittitas, Spokane, Stevens, Walla Walla, Whitman and Yakima counties, which averaged 12.7 per cent. sugar.

In order to awaken as widespread an interest as possible in last year's work, a preliminary bulletin was issued in the winter, which briefly reviewed the history and development of the beet sugar industry in this and in other countries. In this bulletin the proposed work of the year was outlined, and farmers were invited and urged to coöperate with us. We quote from page 14, as follows:

"The agricultural experiment stations exist for the purpose of giving aid to and coöperating with the farmers in matters of this kind. The laboratory of the Washington station is well equipped for doing any work connected with the analysis of sugar beets or their products, and the chemical department is ready to give any aid possible. In a word, it is our earnest desire to form a partnership with all the farmers of the state who are interested in this matter, the basis of partnership to be as follows: We agree to furnish seed and printed directions for the culture of the beet. We further agree to pay transportation charges on all beets sent to the department for analysis, and to make the analyses free of cost; to preserve and correllate the data thus obtained; to print the same in a bulletin, a copy of which will be sent to each farmer. We ask the farmers, on their part, to measure off a definite portion of land, about 10 or 20 feet square, in which the seed will be planted at such time and in such manner as we shall indicate, as nearly as possible; to properly cultivate and otherwise care for the beets during their period of growth, according to directions furnished, as nearly as possible; when the beets have reached maturity, to select samples for analysis, at such time and in such manner as we may prescribe; to send said samples to us; to keep an accurate record of the kind of seed, time of planting, size of plat, quality of soil, kind and amount of cultivation, etc.; also, to carefully estimate the yield and cost of production per acre; and lastly, to furnish us with these and all other data bearing on the subject, for publication."

In response to this bulletin, applications for seed were received from 1015 farmers living in all parts of the state. These applications were all filled, the greater number of them with three varieties of seed, some with two, and a few with only one. Our original plan was to furnish each applicant with three varieties, but was not carried out in all cases because of an insufficient supply. Seed was sent to one or more farmers in every county except Okanogan.

In these coöperative tests, seven varieties of seed were used, as follows: Klein Wanzlebener, Vilmorin Amelioree, Le Maire, Mette, Vilmorin Richest, Vilmorin Improved and Knauer's Imperial. Of these, the first three were distributed in the greater quantities. Printed culture directions were furnished with the seed.

The weather during the past season was so varied in different sections of the state that it would be difficult to summarize the reports received concerning it. In some places the ground was so wet and cold in the spring that the seed failed to germinate. Many experimental plats were ruined by high water. A large number reported a good stand and excellent growth for a few weeks, and then the death of the young plants, due to unusually dry weather and hot winds. All the failures reported as due to climatic causes were attributed to an excess or lack of water; but it is probable that the temperature was, in many cases, unfavorable to a healthy and normal growth of the beet, although the reports did not mention this point. Some few failures were the result of stock depredations. Judging from the numerous complaints received concerning the ground squirrel, it seems quite probable that it may be a serious enemy to combat in sugar beet culture. It is not to be expected that the sugar beet in Washington will escape the ravages of insect enemies. Early in June it was reported that the flea beetle was threatening the young beet plants with serious injury. We immediately issued press bulletin No. 3, giving instructions for fighting this and other enemies of the beet; but owing to an unavoidable delay in printing, it was sent out too late to be of effective service.

Early in September, preliminary arrangements were made for the transportation of the sample beets to the station, and their subsequent analysis. The different railroads very generously granted free freight transportation, thus greatly aiding in the work. At every town in which three or more parties had received seed, one person was secured to superintend the packing and shipping of the samples. The time of harvesting and shipping was designated by us somewhat arbitrarily, so that we might be able to care for the beets as soon as received. This time was, of course, selected with reference to the climatic conditions, so that harvesting would not occur before the beets were matured. Yet, in many cases there were very plain evidences of immaturity, particularly with Western Washington beets, although the majority of them were not har-

vested until November. Samples were received from 384 different parties, more than one-third of the number who received seed, and from all the counties of the state except Clarke, Douglas, Franklin, Kitsap, Klickitat, Mason, Okanogan and Thurston.

The following report blank was sent to each man, to be filled out:

FORM OF REPORT.

1. Varieties of seed planted, $\left\{ \begin{array}{l} (a) \\ (b) \\ (c) \end{array} \right.$
2. Date of planting.
3. Exact area of plats planted, $\left\{ \begin{array}{l} (a) \\ (b) \\ (c) \end{array} \right.$
4. How deep was ground plowed?
5. Character of soil.
6. How much cultivation did the beets receive?
7. Crop grown on same ground preceding year.
8. Distance between rows.
9. Distance between beets in the row.
10. Estimated yield per acre.
11. Date of harvesting.
12. Weather during growing season.
13. Do you think from your experience this year that you could afford to grow beets at \$4 per ton?
14. Were your beets troubled by insects?
15. County.
16. Postoffice.
17. Name.

Three hundred and sixty-five of these reports were returned properly filled out, from which the following data was obtained: 156 answered question 13 in the affirmative, 67 in the negative, and 142 gave no answer; 127 reported trouble from insects. Only a few reported proper attention given the beets during the growing season, and the shape of the samples received gave abundant evidence of shallow plowing and improper cultivation. It was, however, very noticeable that the shape of the beet had no apparent relation to the sugar content. It has been generally found true that a beet showing many rootlets and having a scraggy appearance is not rich in sugar. Repeated observations of this point, made while the analytical work was in progress, failed to establish such a relation. In very many instances beets that were most unpromising in shape and general appearance have shown both high sugar and purity. Nevertheless, for growing factory beets, the cultivation must be of

a character that will produce more regularity in shape and greater smoothness.

Another very significant fact that was revealed by the analytical work is worthy of note. Generally speaking, a high specific gravity of a beet juice may indicate that it contains either a large amount of sugar, or an unusual proportion of solids *not sugar*; which means that the beet is *rich in sugar*, or *low in purity*. With reference to the samples analyzed last year, there has been a direct relation between the specific gravity of the juice and the sugar percentage; in other words, a high specific gravity has almost invariably been indicative of a high percentage of sugar.

Of the different varieties of beets, the Klein Wanzlebener seems to have given the most satisfactory results in regard to tonnage yield, sugar content and purity. Vilmorin Amelioree stands next in point of excellence. All the other varieties, except Vilmorin Improved, are about equal, but do not give as uniform results as the two above mentioned. The Vilmorin Improved has shown itself to be wholly unadapted to our conditions of soil and climate. All of the beets grown from seed that we received marked "Vilmorin Improved" have shown uniformly low sugar and purity, regardless of locality where grown. We have some doubts of the correctness of the label, for this variety in other states has proved very satisfactory; and, also, the beets grown from this doubtful variety exhibited all the characteristics of the inferior sugar beet often raised for stock feeding. From the character of the samples received, we conclude that the Klein Wanzlebener is a deep growing variety, and requires deeper cultivation than the others. The Le Maire variety, if we may judge from last year's experience, is more easily affected by unfavorable conditions than are the others. A large majority of the beets received were grown upon ground that produced vegetables the preceding year, yet these garden spots did not produce beets superior to those grown upon new ground or wheat land.

The total number of samples analyzed was 1,700, coming from 27 different counties and 101 different towns. The following pages give the details of the individual analyses.

EXPLANATION OF TERMS USED.

The figures in the column "weight" express in pounds and ounces the gross weight of the beet after cutting off the tops.

The "sugar in juice" is determined directly by means of the polariscope, and is expressed in per cent.

The "sugar in beet" is found by multiplying the per cent. of sugar in the juice by .95—the weight of the juice being approximate 95 per cent. of the weight of the beet.

The purity is the ratio between the sugar and the total solids in the juice. For example, if 100 parts of solids contain 80 parts of sugar and 20 parts of non-sugar, the co-efficient of purity is said to be 80.

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.....	Date of harvesting	Character of soil.....	Depth of plowing.....	Estimated yield per acre.....	Crop grown on same ground the preceding year	Weight of beet.....	Sugar in juice..	Sugar in beet ...	Purity.....
								lbs. oz.			
W. L. Hanna, Pullman	Knauer's Imperial	May 3	Aug. 23	Clay loam...	16 in.	.....	.....	1 6	11.3	10.7	79.0
Elton Fulmer,	Klein Wanzelebener	"	"	"	"	.....	.....	1 8	13.0	12.4	80.7
"	Vilmorin Ameloree.	"	"	"	"	.....	.....	7	12.8	12.2	79.0
"	Knauer's Imperial	"	"	"	"	.....	.....	6	12.9	12.3	84.2
"	Vilmorin Richet	"	"	"	"	.....	.....	9	14.6	13.9	85.4
"	Mette	"	"	"	"	.....	.....	12	12.4	11.8	81.6
"	Vilmorin Improved	"	"	"	"	.....	.....	13	10.1	9.6	75.9
"	Le Maire.	"	"	"	"	.....	.....	6	12.1	11.5	70.0
E. A. Bryan,	Klein Wanzelebener	Apr. 20	Sept. 10	"	.....	.....	.....	12	16.8	16.0	84.7
John R. Reavis, Fairfield	Mette	"	"	"	.....	.....	.....	18	6.9	6.6	70.9
"	Le Maire.	May 1	"	"	.....	.....	.....	1 5	14.5	13.8	52.7
"	Klein Wanzelebener	Apr. 27	"	"	.....	.....	.....	12	15.7	14.9	74.9
"	"	"	"	"	.....	.....	.....	1 1	13.7	13.0	83.9
"	Le Maire.	Apr. 20	"	"	.....	.....	.....	11	15.5	14.7	85.6
"	Vilmorin Ameloree.	"	"	"	.....	.....	.....	1 3	14.9	14.2	70.4
Elton Fulmer, Pullman	Klein Wanzelebener	May 3	Sept. 12	Clay loam...	16 in.	.....	.....	1 11	14.8	14.1	69.0
"	Le Maire.	"	"	"	"	.....	.....	1 1	14.8	14.1	79.1
"	Vilmorin Ameloree.	"	"	"	"	.....	.....	9	14.3	13.6	78.7
"	Knauer's Imperial	"	"	"	"	.....	.....	5	14.4	13.7	83.1
"	Vilmorin Richet	"	"	"	"	.....	.....	7	11.3	10.7	80.4
"	Mette	"	"	"	"	.....	.....	10	12.8	12.2	60.0
"	Vilmorin Improved	"	"	"	"	.....	.....	10	12.8	12.2	79.5
Geo. W. Elliott, Ellensburg	Klein Wanzelebener	May 1	"	Sandy	"	.....	.....	6	15.0	14.3	71.9
"	Vilmorin Richet	"	"	"	"	.....	.....	12	13.1	12.4	69.1
"	Knauer's Imperial	"	"	"	"	.....	.....	12	16.0	15.2	75.2
Florimond Desprez,	"	"	"	"	"	.....	.....	12	16.0	15.2	82.0
"	"	"	"	"	"	.....	.....	1 11	13.6	12.9	62.7
"	"	"	"	"	"	.....	.....	1 3	15.3	14.5	86.9
"	"	"	"	"	"	.....	.....	1 9	18.0	17.1	87.8
"	"	"	"	"	"	.....	.....	1	17.9	17.0	87.7
"	"	"	"	"	"	.....	.....	7	14.0	13.3	76.9
E. A. Bryan, Pullman	Klein Wanzelebener	May 3	Sept. 22	Clay loam...	16 in.	.....	.....	11	17.4	16.5	74.7
"	Le Maire.	"	"	"	"	.....	.....	14	15.2	14.4	74.5
Elton Fulmer,	Vilmorin Ameloree.	"	"	"	"	.....	.....	14	15.9	15.1	89.3
"	Knauer's Imperial	"	"	"	"	.....	.....	5	13.6	12.9	74.3

W. J. Clemans, Anatone.....	May 22	Oct. 1	Black loam.....	4 in.	19 tons	Beans.....	1	7	14.4	13.7	80.9
" " " "	"	"	"	"	"	"	1	12	15.0	14.2	82.4
E. A. Bryan, Pullman.....	"	"	Low land.....	"	"	"	2	6	15.4	14.6	86.5
" " " "	"	"	"	"	"	"	2	6	12.3	11.7	77.4
" " " "	"	"	"	"	"	"	2	6	15.2	14.4	86.4
" " " "	"	"	"	"	"	"	2	7	14.7	14.0	86.4
" " " "	"	"	"	"	"	"	2	2	13.9	13.2	75.9
K. Erickson, Tekoa.....	May 20	Oct. 3	Black loam.....	10 in.	"	Oats.....	4	4	16.8	16.0	90.8
" " " "	"	"	"	"	"	"	6	5	16.9	16.1	94.4
D. A. Huffman, Tekoa.....	May 15	"	"	"	"	"	1	5	15.8	15.0	84.0
" " " "	"	"	"	"	"	"	1	6	16.0	15.2	89.4
K. Erickson, Tekoa.....	May 20	Oct. 3	"	"	"	"	2	7	15.9	15.1	83.7
" " " "	"	"	"	"	"	"	2	6	13.0	12.4	80.7
" " " "	"	"	"	"	"	"	7	11.1	10.5	79.9	
Le Maire.....	"	"	"	"	"	"	10	14.6	13.9	82.9	
" " " "	"	"	"	"	"	"	9	14.8	14.1	85.1	
Thos. Balken, ".....	May 28	"	"	"	"	Beans.....	8	12.4	11.8	83.9	
" " " "	"	"	"	"	"	"	2	4	13.6	12.9	81.4
J. G. Conger, ".....	Apr. 22	Oct. 1	"	"	"	"	3	8	12.8	12.2	78.5
" " " "	"	"	"	"	"	"	8	10	13.4	12.7	74.9
S. M. Smith, Riparia.....	May 1	Oct. 4	{ Clay or hardpan.....	6 in.	"	Wheat.....	1	13	12.0	11.4	71.8
" " " "	"	"	Sandy loam.....	"	"	"	1	3	16.2	15.4	.....
W. H. Stuart, ".....	Apr. 27	Oct. 5	"	"	"	Nothing.....	3	3	17.4	16.5	.....
John Thompson, Moscow, Ida....	May 2	Oct. 8	Black loam.....	"	"	Tomatoes.....	1	7	13.9	13.2	81.3
" " " "	"	"	"	"	"	"	1	11	16.3	15.5	90.5
" " " "	"	"	"	"	"	Potatoes.....	1	1	15.2	14.4	88.4
" " " "	"	"	"	"	"	"	2	2	13.5	12.8	87.1
" " " "	"	"	"	"	"	"	10	16.4	15.6	83.2	
" " " "	"	"	"	"	"	"	7	16.1	15.3	92.5	
" " " "	"	"	"	"	"	"	8	16.4	15.6	87.7	
" " " "	"	"	"	"	"	"	9	17.4	16.5	85.6	
" " " "	"	"	"	"	"	Sweet corn.....	1	10	14.9	14.2	86.6
A. J. Bolter, Dixie.....	Apr. 28	Oct. 3	"	"	"	"	1	3	14.3	13.6	85.6
" " " "	"	"	"	"	"	Potatoes.....	1	12	13.8	13.1	83.1
H. D. Eldridge, Dixie.....	May 5	"	Sandy loam.....	8 in.	20 tons	"	1	3	13.5	12.8	83.3
" " " "	"	"	"	"	"	"	1	4	14.8	14.1	86.5
D. J. Kelly, Dixie.....	May 7	"	"	"	"	"	1	6	14.4	13.7	84.7
" " " "	"	"	"	"	"	"	1	4	14.6	13.9	87.4
" " " "	"	"	"	"	"	"	1	4	15.1	14.3	91.5
B. F. Sherfey, Diamond.....	Apr. 28	Oct. 6	Clay loam.....	7 in.	2½ tons	"	7	15.7	14.9	92.8	
" " " "	"	"	"	"	"	"	7	16.9	16.1	87.5	
Le Maire.....	"	"	"	"	"	"	9	20.9	19.9	92.0	
A. A. J. Harris, Plaza.....	May 1	Oct. 3	Black loam.....	10 in.	22 tons	Potatoes.....	2	3	18.4	17.5	90.0
" " " "	"	"	"	"	"	"	2	3	19.3	18.3	91.4
C. T. Cowan, ".....	May 23	"	"	"	"	Cabbage.....	2	10	17.4	16.5	90.6
" " " "	"	"	"	"	"	"	2	2	15.0	14.2	79.8
W. E. Schneider, Plaza.....	Apr. 21	"	"	"	"	Turnips.....	13	13	15.9	15.1	86.9

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONTINUED.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.....	Date of harvesting.....	Character of soil.....	Depth of plowing.....	Estimated yield per acre.....	Crop grown on same ground the preceding year.....	Weight of beet..... lbs. oz.	Sugar in juice..	Sugar in beet...	Purity.....
B. F. Sherfey, Diamond.	Klein Wanzlebener...	Apr. 28	Oct. 6	Alkali.....	7 in.	2½ tons	Potatoes.....	8	15.5	14.7	88.0
W. M. Lee, " "	Vilmorin Improved...	Apr. 25	Oct. 5	Light loam.....	" "	" "	" "	5	14.8	14.1	86.0
B. F. Sherfey, " "	" " "	" "	" "	" "	" "	" "	" "	3	12.5	11.9	69.1
J. H. Wees, Marshall.	Le Maire.....	Apr. 28	Oct. 6	Alkali.....	" "	2½ tons	" "	2	13.6	12.9	79.1
" " "	Vilmorin Improved...	May 5	Oct. 7	Sandy.....	5 in.	12 tons	Nothing.....	1	16.2	15.4	87.1
" " "	" " "	" "	" "	" "	" "	" "	" "	3	16.0	15.2	89.4
C. O. Lybecker, Plaza.	" " "	May 3	Oct. 3	Black loam.....	10 in.	18 tons	Wheat.....	2	12.2	11.6	78.2
" " "	Knauer's Imperial...	May 4	" "	" "	" "	" "	" "	4	14.2	13.5	85.0
H. J. Ledbetter, Rosalia.	Klein Wanzlebener...	May 20	" "	" "	8 in.	" "	Cabbage.....	2	15.8	15.0	75.9
" " "	" " "	" "	" "	" "	" "	" "	" "	13	16.7	16.7	89.8
J. H. Olsen, " "	Vilmorin Ameliorée...	May 1	Oct. 8	" "	" "	" "	Potatoes.....	7	15.3	14.5	88.9
" " "	" " "	" "	" "	" "	" "	" "	" "	10	16.8	16.0	97.6
C. H. Miller, " "	Klein Wanzlebener...	" "	" "	" "	" "	12 tons	Wheat.....	9	18.2	17.3	94.7
" " "	" " "	" "	" "	" "	" "	" "	" "	2	14.3	13.6	82.2
" " "	" " "	" "	" "	" "	" "	" "	" "	7	14.4	13.7	85.2
J. H. Olson, " "	Le Maire.....	" "	" "	" "	" "	" "	Potatoes.....	6	16.7	15.9	81.9
Fred. Widmann, " "	Knauer's Imperial...	May 15	" "	" "	7 in.	" "	Vegetables.....	5	19.6	18.6	90.3
" " "	" " "	" "	" "	" "	" "	" "	" "	5	17.4	16.5	88.7
J. H. Olson, " "	Klein Wanzlebener...	May 1	Oct. 8	" "	8 in.	" "	Potatoes.....	7	19.7	18.7	94.2
" " "	" " "	" "	" "	" "	" "	" "	" "	5	14.5	13.8	90.6
W. P. Ward, " "	Knauer's Imperial...	May 3	" "	" "	" "	" "	Nothing.....	5	14.9	14.2	91.4
" " "	" " "	" "	" "	" "	" "	" "	" "	5	18.0	17.1	86.5
L. L. Wright, Guy.	Le Maire.....	May 28	Oct. 10	Dark.....	14 in.	" "	" "	7	17.5	16.6	89.7
" " "	" " "	" "	" "	" "	" "	" "	" "	14	16.8	16.0	93.3
Eugene Rice, " "	Mette.....	" "	" "	" "	10 in.	" "	" "	3	13.2	12.5	79.5
" " "	" " "	" "	" "	" "	" "	" "	" "	4	15.2	14.4	84.0
L. L. Wright, " "	" " "	May 28	Oct. 10.	" "	14 in.	" "	Nothing.....	8	14.9	14.2	87.6
" " "	" " "	" "	" "	" "	" "	" "	" "	9	17.1	16.2	89.0
" " "	Klein Wanzlebener...	" "	" "	" "	" "	" "	" "	9	16.3	15.5	93.7
" " "	" " "	" "	" "	" "	" "	" "	" "	14	17.0	16.2	94.9
" " "	Vilmorin Ameliorée...	" "	" "	" "	" "	" "	" "	12	14.5	13.8	85.8
" " "	" " "	" "	" "	" "	" "	" "	" "	11	17.8	16.9	90.3
M. M. Merritt, Rosalia.	Knauer's Imperial...	May 21	Oct. 8	Black.....	10 in.	9 tons	Wheat.....	1	16.2	15.4	87.0
" " "	" " "	" "	" "	" "	" "	" "	" "	1	14	16.7	87.9
W. J. Thompson, Guy.	Klein Wanzlebener...	May 20	" "	D'rks s'dy l'm.	" "	5 tons	Potatoes.....	3	16.6	15.8	89.2

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONTINUED.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.....	Date of harvesting.....	Character of soil.....	Depth of plowing.....	Estimated yield per acre.....	Crop grown on same ground the preceding year.....	Weight of beet..... lbs. oz.	Sugar in juice..	Sugar in beet...	Purity
D. B. Williams, Pataha City.....	Klein Wanzelebener.....	May 5	Oct. 8	Dark loam.....	8 in.	14 tons	Corn.....	1 7	16.6	15.8	86.5
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	3 5	13.7	13.0	80.1
J. M. Williams, Pataha City.....	" " " ".....	May 10	" " " "	Sandy.....	10 in.	15 tons	Carrots.....	5 5	10.8	10.3	71.1
R. R. Santo, Pataha City.....	Knaener's Imperial.....	Apr. 5	" " " "	Sandy loam.....	5 in.	5 tons	Nothing.....	4 8	10.8	10.3	73.0
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	7 12	12.9	12.9	82.9
Clyde Lee, Yakima City.....	Vilmorin Amelioree.....	May 10	Oct. 5	Volcanic ash.....	4 in.	20 tons	Oats.....	15 15	11.5	10.9	87.0
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	1 6	14.4	13.7	76.2
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	1 1	13.0	12.4	82.3
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	1 10	14.1	13.4	78.3
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	2 4	13.6	12.9	81.4
R. C. Johnson, Farmington.....	" " " ".....	" " " "	" " " "	Clay loam.....	7 in.	" " " "	" " " "	2 4	14.8	14.1	84.1
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	4 10	12.1	11.5	80.1
R. Alderson, Farmington.....	Mette.....	May 1	Oct. 6	Loose black.....	8 in.	" " " "	Potatoes.....	4 2	15.0	14.3	82.9
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	1 3	12.4	11.8	81.6
R. C. Johnson, Farmington.....	Klein Wanzelebener.....	" " " "	" " " "	Clay loam.....	7 in.	" " " "	Oats.....	1 10	11.3	10.7	75.9
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	2 14	12.7	12.1	78.4
O. A. Felton, Farmington.....	" " " ".....	May 31	Oct. 6	Dark loam.....	" " " "	" " " "	Cabbage.....	1 9	14.5	13.8	82.8
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	2 2	15.0	14.3	81.5
R. S. Kingsbury, Farmington.....	Vilmorin Amelioree.....	May 1	" " " "	" " " ".....	" " " "	8½ tons	Nothing.....	2 1	13.9	13.2	80.8
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	2 2	13.3	13.6	82.2
" " " ".....	Klein Wanzelebener.....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	2 5	13.8	13.1	78.9
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	2 2	14.0	14.0	83.5
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	2 4	14.7	14.0	83.5
" " " ".....	Le Maire.....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	12 12	14.0	13.3	80.5
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	12 14	14.4	13.7	86.2
L. E. Rowe, Centralia.....	Klein Wanzelebener.....	May 7	Sept. 1	Sandy loam.....	10 in.	11 tons	Carrots.....	6 6	15.0	14.3	82.0
" " " ".....	Vilmorin Amelioree.....	" " " "	" " " "	" " " ".....	" " " "	12 tons	" " " "	12 12	15.1	14.4	81.2
" " " ".....	Le Maire.....	" " " "	" " " "	" " " ".....	" " " "	8½ tons	" " " "	8 8	15.8	15.0	86.3
L. F. Eccles, Fletcher.....	Mette.....	May 19	Oct. 5	Black alluvial.....	7 in.	8 tons	Watermelons.....	11 11	14.3	13.6	86.1
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	8 8	14.9	14.2	88.7
E. E. Ellis, " ".....	" " " ".....	Apr. 10	Oct. 8	Sandy loam.....	6 in.	" " " "	Cabbage.....	12 12	14.8	14.1	85.5
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	4 4	14.4	13.7	84.7
L. F. Eccles, " ".....	Klein Wanzelebener.....	May 19	Oct. 5	Black alluvial.....	7 in.	8 tons	Watermelons.....	9 9	15.3	14.5	86.4
Samuel Glenn, Fletcher.....	" " " ".....	May 10	Oct. 4	Light loam.....	5 in.	" " " "	Nothing.....	6 6	10.5	10.0	84.7
" " " ".....	" " " ".....	" " " "	" " " "	" " " ".....	" " " "	" " " "	" " " "	9 9	13.1	12.4	73.2
Seymour Shoultes, Marysville.....	Le Maire.....	May 12	Oct. 11	Sandy loam.....	14 in.	" " " "	Buckwheat.....	13 13	13.9	13.2	83.2

Seymour Shouites, Marysville...	Klein Wanzlebener...	May 12	Oct. 11	Sandy loam...	14 in.	.....	Buckwheat,	7	15.1	14.3	92.6
" " " "	Vilmorin Ameliorée.	" "	" "	" "	" "	" "	" "	6	11.7	11.1	80.7
" " " "	" " " "	" "	" "	" "	" "	" "	" "	10	13.4	12.7	81.2
D. T. C. Bird, Colville...	Klein Wanzlebener...	May 2	Oct. 13	" "	10 in.	" "	Potatoes....	12	11.8	11.2	80.8
" " " "	" " " "	" "	" "	" "	" "	" "	" "	9	14.7	13.0	84.5
" " " "	Vilmorin Ameliorée.	" "	" "	" "	" "	" "	" "	1	11	16.2	93.1
" " " "	" " " "	" "	" "	" "	" "	" "	" "	1	1	13.7	85.6
" " " "	Le Maire.	" "	" "	" "	" "	" "	" "	1	15	13.5	84.9
" " " "	" " " "	" "	" "	" "	" "	" "	" "	2	3	12.4	84.8
" " " "	Vilmorin Ameliorée.	" "	" "	" "	" "	" "	" "	1	9	13.4	81.7
John E. Morrow, Colville...	" " " "	" "	" "	" "	" "	" "	" "	1	8	16.6	86.5
" " " "	" " " "	" "	" "	" "	" "	" "	" "	1	3	14.5	81.9
" " " "	Klein Wanzlebener...	" "	" "	" "	" "	" "	" "	12	19.8	18.8	87.2
" " " "	Le Maire.	" "	" "	" "	" "	" "	" "	10	18.0	17.1	83.3
" " " "	" " " "	" "	" "	" "	" "	" "	" "	15	19.7	18.7	93.8
J. B. Taylor, Ellensburg...	Vilmorin Ameliorée.	" "	" "	" "	" "	" "	" "	10	18.8	17.9	90.0
" " " "	" " " "	" "	" "	" "	" "	" "	" "	10	18.1	17.2	89.6
" " " "	Klein Wanzlebener.	" "	" "	" "	" "	" "	" "	14	18.3	17.4	93.3
" " " "	" " " "	" "	" "	" "	" "	" "	" "	9	18.4	17.5	95.8
John Burglin,	" " " "	" "	" "	" "	" "	" "	" "	11	13.0	12.4	75.6
" " " "	" " " "	" "	" "	" "	" "	" "	" "	11	10.2	9.7	64.5
" " " "	" " " "	" "	" "	" "	" "	" "	" "	9	11.4	10.8	75.0
C. H. Harding, Farmington...	Vilmorin Improved.	May 20	" "	Black loam...	8 in.	" "	Cabbage	1	12.2	11.6	72.2
" " " "	" " " "	" "	" "	" "	" "	" "	" "	8	12	7.7	63.6
" " " "	" " " "	" "	" "	" "	" "	" "	" "	6	12	9.5	9.0
" " " "	" " " "	" "	" "	" "	" "	" "	" "	6	5.8	5.5	57.4
W. F. Eckhart, Wabash...	" " " "	May 28	Oct. 12	Gravelly clay.	12 in.	" "	" "	2	7.8	7.4	64.5
" " " "	" " " "	" "	" "	" "	" "	" "	" "	9	11.7	11.1	83.6
" " " "	Mette	" "	" "	" "	" "	" "	" "	9	11.8	11.2	77.6
" " " "	" " " "	" "	" "	" "	" "	" "	" "	11	11.9	11.3	83.8
Ernest Becker, Colton...	Vilmorin Improved...	Apr. 25	" "	Black loam...	10 in.	" "	Carrots	1	11.9	11.3	78.1
" " " "	" " " "	" "	" "	" "	" "	" "	" "	2	13	10.2	9.7
" " " "	" " " "	" "	" "	" "	" "	" "	" "	5	1	8.2	71.3
" " " "	" " " "	" "	" "	" "	" "	" "	" "	5	1	4.7	4.5
" " " "	" " " "	" "	" "	" "	" "	" "	" "	3	9.7	9.2	70.3
A. L. Webster, Garfield...	Le Maire.	June 1	Oct. 10	Clay loam...	8 in.	" "	Potatoes	1	7	14.6	13.9
" " " "	Vilmorin Ameliorée.	Apr. 24	" "	" "	" "	" "	" "	1	12	14.9	86.1
" " " "	" " " "	" "	" "	" "	" "	" "	" "	1	11	16.3	85.3
" " " "	Le Maire.	" "	" "	" "	" "	" "	" "	1	4	13.3	82.1
C. W. Lyman,	Vilmorin Ameliorée.	" "	" "	" "	" "	" "	" "	1	8	12.0	11.4
" " " "	" " " "	" "	" "	" "	" "	" "	" "	1	1	11.6	11.0
" " " "	" " " "	" "	" "	" "	" "	" "	" "	1	7	12.0	11.4
" " " "	Vilmorin Ameliorée.	" "	" "	" "	" "	" "	" "	1	4	15.7	14.9
" " " "	" " " "	" "	" "	" "	" "	" "	" "	6	17.3	16.4	92.0
Klein Wanzlebener...	" " " "	" "	" "	" "	" "	" "	" "	11	17.0	16.2	88.1
" " " "	" " " "	June 1	Oct. 10	Clay loam...	8 in.	" "	Potatoes	1	12	15.5	14.7
" " " "	" " " "	" "	" "	" "	" "	" "	" "	1	15.6	14.8	80.8
A. L. Webster,	Vilmorin Ameliorée.	Apr. 27	" "	Rich loam...	" "	" "	Nothing....	5	13.0	12.4	75.1
" " " "	" " " "	" "	" "	" "	" "	" "	" "				

Asa White, Colfax.....	May 1	Oct. 15	Black loam.....	14 in.	15 tons	Wheat.....	5	18.0	17.1	93.2	
" " " " " "	"	"	"	"	"	"	6	17.3	16.4	95.5	
R. J. Evans, " " " " " "	Apr. 26	"	"	6 in.	"	Nothing.....	5	17.7	16.8	94.1	
" " " " " "	"	"	"	"	"	"	2	14.9	14.2	82.3	
Klein Wanzlebener.....	"	"	"	"	"	"	2	12.9	12.3	75.0	
" " " " " "	"	"	"	"	"	"	2	9	12.2	11.6	77.7
Le Maire.....	"	"	"	"	"	"	1	7	14.0	13.3	80.5
" " " " " "	"	"	"	"	"	"	1	13	13.5	12.8	80.3
Klein Wanzlebener.....	May 21	"	"	8 in.	8½ tons	Cabbage.....	1	14	14.1	13.4	82.0
" " " " " "	"	"	"	"	"	"	7	17.0	16.2	88.1	
" " " " " "	May 8	"	Clay loam.....	10 in.	"	Wheat.....	11	15.1	14.3	80.3	
Le Maire.....	"	"	"	"	"	"	7	14.5	13.8	81.9	
" " " " " "	"	"	"	"	"	"	15	16.4	15.6	91.1	
Vilmorin Amelioree.....	"	"	"	"	"	"	1	4	15.3	14.5	81.4
" " " " " "	"	"	"	"	"	"	9	15.3	14.5	85.5	
Klein Wanzlebener.....	Apr. 26	Oct. 12	Dark loam.....	"	20 tons	Barley.....	10	15.7	14.9	89.7	
" " " " " "	"	"	"	"	"	"	12	13.8	13.1	76.2	
Vilmorin Amelioree.....	"	"	"	"	"	"	12	15.4	14.6	88.5	
Le Maire.....	"	"	"	"	"	"	13	15.1	14.3	90.4	
" " " " " "	"	"	"	"	"	"	13	14.9	14.2	84.2	
" " " " " "	"	"	"	"	"	"	15	14.7	14.0	80.8	
O. L. Wolfard, Colfax.....	Apr. 27	Oct. 15	Clay loam.....	"	5 tons	Pumpkins.....	1	16.0	15.2	87.0	
" " " " " "	"	"	"	"	"	"	1	10	14.2	13.5	89.3
Klein Wanzlebener.....	"	"	"	"	"	"	10	16.0	15.2	87.4	
" " " " " "	"	"	"	"	"	"	12	15.3	14.5	91.0	
Vilmorin Amelioree.....	"	"	"	"	"	"	5	13.5	12.8	77.2	
" " " " " "	"	"	"	"	"	"	11	16.2	15.4	86.6	
Unknown.....	"	"	"	"	"	"	10	18.2	17.3	90.5	
" " " " " "	"	"	"	"	"	"	9	16.7	15.9	89.7	
" " " " " "	"	"	"	"	"	"	1	6	14.3	13.6	76.1
" " " " " "	"	"	"	"	"	"	1	5	16.0	15.2	76.8
" " " " " "	"	"	"	"	"	"	1	2	17.2	16.3	86.0
" " " " " "	"	"	"	"	"	"	1	6	15.6	14.8	82.1
" " " " " "	"	"	"	"	"	"	1	8	15.8	15.0	87.3
Vilmorin Amelioree.....	"	"	"	"	"	"	1	1	16.1	15.3	84.7
" " " " " "	"	"	"	"	"	"	14	16.4	15.6	90.6	
Klein Wanzlebener.....	May 5	Oct. 15	Dark loam.....	6 in.	10 tons	Potatoes.....	16	17.5	16.6	96.4	
Le Maire.....	"	"	"	"	"	"	9	18.1	17.2	92.8	
" " " " " "	"	"	"	"	"	"	13	19.5	18.5	91.1	
Vilmorin Amelioree.....	"	"	"	"	"	"	1	1	19.6	18.6	91.1
" " " " " "	"	"	"	"	"	"	1	4	18.8	17.9	88.6
Klein Wanzlebener.....	May 1	Oct. 9	Sandy loam.....	"	"	Nothing.....	1	1	19.8	18.8	94.3
" " " " " "	"	"	"	"	"	"	1	1	19.5	18.5	91.1
John F. McCroskey, Oakesdale.....	May 15	Oct. 10	"	"	"	Nothing	2	12	15.0	14.3	82.0
" " " " " "	"	"	"	"	"	"	3	10	11.8	11.2	77.6
J. H. McDowell, Oakesdale.....	Oct. 9	"	Rich loam.....	7 in.	"	Potatoes.....	5	15.6	14.8	88.1	
H. G. Lane, Oakesdale.....	"	"	"	"	"	Wheat.....	3	16.0	15.2	82.0	
" " " " " "	"	"	"	"	"	"	2	11	15.0	14.3	80.2

J. C. Turner, Colfax.	May 7	Oct. 16	Dark loam.	7 in.	.....	Garden.	1 14	15 7	14 9	90 2
"	"	"	"	"	"	"	2 8	14 1	13 4	82 0
"	"	"	"	"	"	"	11	14 0	13 3	82 3
"	"	"	"	"	"	"	7	16 8	16 0	87 0
Le Maire.	"	"	"	"	"	"	1 5	13 6	12 9	75 1
"	"	"	"	"	"	"	2 13	14 2	13 5	75 1
Klein Wanzlebener.	"	"	"	"	"	"	3 3	12 2	11 6	71 8
"	"	"	"	"	"	"	11	12 0	11 4	75 0
Geo. Light, Pomeroy.	May 15	"	Brown loam.	8 in.	.....	Vegetables.	1 4	17 6	16 7	82 2
"	"	"	"	"	"	"	1 3	16 3	15 5	81 1
J. R. Wheeler, Pomeroy	May 2	"	Sandy	"	3 tons	Wheat.	1 5	15 3	14 4	83 2
"	"	"	"	"	"	"	2	16 0	15 2	82 5
"	"	"	"	"	"	"	3 7	13 0	12 4	71 2
"	"	"	"	"	"	"	1 14	16 0	15 2	84 7
"	"	"	"	"	"	"	2 1	15 4	14 6	82 4
"	"	"	"	"	"	"	2 2	11 2	10 6	70 9
Albert Ford,	"	"	"	"	"	"	3	13 0	12 4	74 7
"	"	"	"	"	"	"	4 3	14 5	13 8	76 7
A. Oliver,	Apr. 16	Oct. 16	Heavy soil.	8 in.	8 tons	Wheat.	2 7	16 2	15 4	85 7
"	"	"	"	"	"	"	2 6	15 6	14 8	82 1
Albert Ford,	"	"	"	"	"	"	1 12	15 5	14 7	79 1
Z. A. Baldwin,	"	"	"	"	"	"	2 4	15 8	15 0	81 4
Jeffrey Williams, Pomeroy.	May 15	Oct. 16	Sandy loam.	8 in.	.....	Potatoes.	2 8	16 7	15 9	86 5
"	"	"	"	"	"	"	2 2	16 8	16 0	85 9
"	"	"	"	"	"	"	2 8	16 1	15 3	83 0
"	"	"	"	"	"	"	2 4	15 6	14 8	82 5
"	"	"	"	"	"	"	2 6	16 2	15 4	85 3
"	"	"	"	"	"	"	1 7	15 4	14 6	82 4
"	"	"	"	"	"	"	2 2	15 5	14 7	81 6
John Oliver,	Apr. 10	"	Sandy	10 in.	.....	Garden.	2 11	15 1	14 3	80 3
"	"	"	"	"	"	"	1 14	12 8	12 2	73 5
J. R. Wheeler,	May 2	"	"	8 in.	.....	Wheat.	3 2	11 0	10 5	66 6
"	"	"	"	"	"	"	2 1	13 3	12 6	75 2
"	"	"	"	"	"	"	3 13	11 7	11 1	74 1
"	"	"	"	"	"	"	2 15	13 5	12 8	77 6
"	"	"	"	"	"	"	2 13	12 8	12 2	74 4
"	"	"	"	"	"	"	1 8	14 8	14 1	81 3
"	"	"	"	"	"	"	1 11	15 5	14 7	85 1
A. Oliver,	Apr. 16	"	Heavy soil.	"	8 tons	"	2 6	15 4	14 6	87 6
"	"	"	"	"	"	"	2 12	14 4	13 7	83 7
James McCance, Pataha City.	"	"	"	"	"	"	1 13	14 1	13 7	77 8
Thos. Kennedy, Colfax.	"	"	"	"	"	"	1 3	15 8	15 0	81 0
"	"	"	"	"	"	"	1 8	14 1	13 4	81 5
Josiah Crampton, Colfax.	May 18	Oct. 15	Clay loam.	8 in.	.....	Wheat.	1 8	14 7	14 0	77 8
"	"	"	"	"	"	"	1 15	16 1	15 3	84 7
"	"	"	"	"	"	"	1 6	15 3	14 5	81 4
"	"	"	"	"	"	"	1 8	16 1	15 3	84 3

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONTINUED.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.....	Date of harvesting.....	Character of soil.....	Depth of plowing.....	Estimated yield per acre.....	Crop grown on same ground the preceding year	Weight of beet.....	Sugar in juice..	Sugar in beet...	Purity
Josiah Crampton, Colfax.....	Vilmorin Ameliorée.	May 18	Oct. 15	Clay loam.....	8 in.	.....	Wheat.....	lbs. oz.	15.4	14.6	82.8
John Devlin, ".....	Mette ".....	May 1	Oct. 16	" ".....	"	8 tons	Weeds.....	1 11	13.7	13.0	80.6
J. D. Evans, ".....	Vilmorin Improved.....	May 19	Oct. 15	" ".....	7 in.	.....	" ".....	2 4	12.3	11.4	77.9
Southern Bros., Aurora.....	Klein Wanzlebener.....	May 30	"	Black loam.....	13 in.	30 tons	Cabbage.....	2 2	12.9	12.3	74.6
" ".....	" ".....	"	"	" ".....	"	"	Nothing.....	1 3	12.4	11.8	78.1
" ".....	" ".....	"	"	" ".....	"	"	" ".....	1 2	16.1	15.3	86.1
" ".....	Vilmorin Improved.....	"	"	" ".....	"	"	" ".....	1 14	14.0	13.3	80.9
" ".....	Vilmorin Ameliorée.....	"	"	" ".....	"	"	" ".....	1 1	14.4	13.7	87.8
" ".....	" ".....	"	"	" ".....	"	"	" ".....	1 1	13.6	12.9	83.9
" ".....	" ".....	"	"	" ".....	"	"	" ".....	1 8	15.2	14.4	83.1
J. D. Cox, Spokane.....	" ".....	May 10	"	Sandy loam.....	6 in.	8 tons	Onions.....	8	12.5	11.9	87.4
" ".....	" ".....	"	"	" ".....	"	"	" ".....	13	13.0	12.4	83.3
" ".....	Klein Wanzlebener.....	"	"	" ".....	"	"	" ".....	1 11	15.4	14.6	82.4
" ".....	" ".....	"	"	" ".....	"	"	" ".....	12	17.8	16.9	86.3
" ".....	" ".....	"	"	" ".....	"	"	" ".....	1	16.3	15.5	84.0
" ".....	Le Maire.....	"	"	" ".....	"	"	" ".....	15	14.2	13.5	77.6
" ".....	" ".....	"	"	" ".....	"	"	" ".....	13	15.6	14.8	84.8
M. H. Cox, Spokane.....	Klein Wanzlebener.....	May 20	"	Black loam.....	7 in.	.....	Wheat.....	13	13.6	12.9	83.9
" ".....	" ".....	"	"	" ".....	"	.....	" ".....	13	13.1	12.4	82.4
" ".....	Le Maire.....	"	"	" ".....	"	.....	" ".....	9	13.8	13.1	77.1
" ".....	" ".....	"	"	" ".....	"	.....	" ".....	15	14.9	14.2	79.3
" ".....	Vilmorin Ameliorée.....	"	"	" ".....	"	.....	" ".....	15	14.9	14.2	79.3
" ".....	" ".....	"	"	" ".....	"	.....	" ".....	1	14.7	14.0	87.5
L. H. Flatter, ".....	Klein Wanzlebener.....	May 1	Oct. 15	Sandy loam.....	"	2 tons	Onions.....	15	14.7	14.0	82.1
" ".....	" ".....	"	"	" ".....	"	"	" ".....	13	15.9	15.1	80.7
" ".....	Le Maire.....	"	"	" ".....	"	"	" ".....	9	16.9	16.1	84.5
" ".....	Vilmorin Ameliorée.....	"	"	" ".....	"	"	" ".....	7	16.9	16.1	85.9
" ".....	Klein Wanzlebener.....	"	"	" ".....	"	"	" ".....	13	15.8	15.0	81.0
E. L. Perkins, Medical Lake.....	" ".....	June 10	"	" ".....	8 in.	15 tons	Potatoes.....	1	12.9	12.3	77.7
" ".....	Vilmorin Ameliorée.....	"	"	" ".....	"	"	" ".....	1	16.5	15.7	84.2
Amos Bowerman, ".....	Vilmorin Improved.....	"	Oct. 13	Clay loam.....	"	5 tons	Nothing.....	13	11.3	10.7	68.1
" ".....	" ".....	"	"	" ".....	"	"	" ".....	14	11.3	10.7	66.1
" ".....	Klein Wanzlebener.....	"	"	" ".....	"	2½ tons	" ".....	8	16.0	15.2	71.7
" ".....	" ".....	"	"	" ".....	"	"	" ".....	1	18.5	17.6	78.0
J. E. Fitch, Roche Harbor.....	" ".....	"	"	" ".....	"	"	" ".....	3	14	10.9	69.0
" ".....	Mette.....	"	"	" ".....	"	"	" ".....	14	9.0	8.6	60.9

August Reichert, Newcastle...	Le Maire...	May 10	.....	Sandy loam...	8 in.	Potatoes...	1	11.2	10.6	71.3
"	"	"	"	"	"	"	1	10.0	9.5	67.1
"	Klein Wanzeleber...	"	"	"	"	"	2	11.3	10.7	72.0
"	"	"	"	"	"	"	1	9	11.4	71.7
"	Vilmorin Ameloree...	"	"	"	"	"	15	14	10.8	71.7
"	"	"	"	"	"	"	15	13.4	12.7	78.4
C. W. Cotton, Mayview...	Klein Wanzeleber...	May 3	Oct. 12	"	12 in.	Onions...	1	8	14.2	78.9
"	"	"	"	"	"	"	2	12	13.5	77.6
J. M. Reid,	Mette...	"	"	"	"	"	3	8	12.8	77.6
"	"	"	"	"	"	"	2	11.9	11.3	69.6
"	"	"	"	"	"	"	2	13.5	12.8	74.7
"	"	"	"	"	"	"	2	9	15.2	74.7
"	"	"	"	"	"	"	1	13	14.4	78.8
L. C. Richardson,	Vilmorin Ameloree...	May 20	"	Black loam...	8 in.	Potatoes...	1	12	13.7	77.0
"	"	"	"	"	"	"	3	11	15.3	79.3
"	"	"	"	"	"	"	3	11	13.8	78.9
"	Klein Wanzeleber...	"	"	"	"	"	2	6	16.6	84.7
"	"	"	"	"	"	"	1	11	12.9	78.2
"	Mette...	"	"	"	"	"	1	11	14.7	81.7
"	"	"	"	"	"	"	1	11	14.7	81.7
"	"	"	"	"	"	"	1	8	14.8	82.2
"	"	"	"	"	"	"	1	8	13.9	79.4
Moses Bull, Pullman...	"	May 21	Oct. 18	"	"	Garden...	1	14	18.5	86.0
"	"	"	"	"	"	"	1	9	18.6	83.8
D. M. Sanders,	Knauer's Imperial...	May 20	"	"	10 in.	Cucumbers...	1	2	16.7	82.7
"	"	"	"	"	"	"	1	2	17.5	86.6
J. C. Stratton,	Vilmorin Ameloree...	May 11	"	"	8 in.	Parsnips...	2	2	15.9	83.7
"	"	"	"	"	"	"	1	9	16.5	83.7
"	Klein Wanzeleber...	"	"	"	"	"	1	4	16.9	82.0
"	"	"	"	"	"	"	1	14	15.9	82.0
"	Le Maire...	"	"	"	"	"	1	13	17.0	84.5
"	"	"	"	"	"	"	1	13	18.0	84.5
J. L. Metsker,	Knauer's Imperial...	May 19	"	"	10 in.	Timothy...	2	7	16.1	83.0
"	"	"	"	"	"	"	2	7	16.1	83.0
Moses Bull,	Vilmorin Ameloree...	May 20	"	"	"	"	2	7	16.6	83.8
"	"	"	"	"	"	"	1	9	17.3	82.3
"	"	"	"	"	"	"	1	8	17.2	85.1
W. L. La Follette, Guy...	Klein Wanzeleber...	June 9	"	"	8 in.	Garden...	2	7	14.7	82.1
"	"	"	"	"	"	"	1	10	14.8	85.1
"	Vilmorin Ameloree...	"	"	"	"	"	1	8	16.0	85.1
"	"	"	"	"	"	"	1	3	16.0	85.6
"	"	"	"	"	"	"	1	5	15.5	85.6
"	"	"	"	"	"	"	1	5	14.7	82.9
Le Maire...	"	"	"	"	"	"	1	2	14.9	84.2
"	"	"	"	"	"	"	1	2	14.7	83.0
Mette...	"	"	"	"	"	"	1	1	14.7	83.0
"	"	May 1	"	Sandy...	6 in.	Cabbages...	2	9	12.9	81.6
"	"	"	"	"	"	"	2	6	12.7	78.4
"	"	"	"	"	"	"	2	6	13.0	76.9
Vilmorin Ameloree...	"	"	"	"	"	"	2	10	12.0	77.4
"	"	"	"	"	"	"	10	16.3	15.5	79.5
Klein Wanzeleber...	"	"	"	"	"	"	10	17.9	17.0	86.1
"	"	"	"	"	"	"	1	4	17.5	88.8
"	"	"	"	"	"	"	12	19.7	18.7	84.5

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONTINUED.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.....	Date of harvesting	Character of soil.....	Depth of plowing.....	Estimated yield per acre	Crop grown on same ground the preceding year	Weight of beet.....	Sugar in juice..	Sugar in beet...	Purity.....
								lbs. oz.			
W. D. Jones, Asotin.....	Le Maire.....	"	"	"	"	"	"	1 11	15.4	14.6	81.9
" " "	"	"	"	"	"	"	"	1	2	16.5	84.4
J. K. Rice, " " "	Vilmorin Amelioree..	"	"	"	"	"	"	6	18.9	18.0	82.2
" " "	Le Maire.....	"	"	"	"	"	"	6	19.0	18.1	83.2
M. G. Marsilliott, Asotin.....	Klein Wanzlebener..	May 24	Oct. 9	Bench land.....	6 in.	"	Corn.....	3	21.9	20.8	92.7
" " "	"	"	"	"	"	"	"	11	18.3	17.4	91.0
" " "	Knauer's Imperial....	"	"	"	"	"	"	15	14.8	14.1	83.1
" " "	"	"	"	"	"	"	"	6	13.4	12.7	84.3
" " "	Vilmorin Amelioree..	"	"	"	"	"	"	5	17.0	16.2	89.5
" " "	"	"	"	"	"	"	"	8	13.3	12.6	86.9
J. M. Jones, " " "	Le Maire.....	"	Oct. 8	Sandy loam.....	12 in.	"	Barley.....	9	14.6	13.9	86.4
" " "	"	"	"	"	"	"	"	5	17.7	16.8	86.0
" " "	Klein Wanzlebener..	"	"	"	"	"	"	11	16.0	15.2	82.9
" " "	"	"	"	"	"	"	"	1	4	15.7	83.5
" " "	Vilmorin Amelioree..	"	"	"	"	"	"	9	19.0	18.1	92.6
" " "	"	"	"	"	"	"	"	12	18.6	17.7	90.7
Thos. Dell, Belmont.....	"	"	"	"	"	"	"	10	19.0	18.1	88.3
" " "	"	"	"	"	"	"	Potatoes.....	1	13	16.5	84.2
" " "	May 1	Oct. 13	"	Black loam.....	10 in.	"	"	2	12	14.9	80.5
" " "	"	"	"	"	"	"	"	3	12	14.9	79.3
" " "	"	"	"	"	"	"	"	2	10	14.6	77.6
Unknown.....	Unknown.....	"	"	"	"	"	"	2	10	14.8	79.6
" " "	"	"	"	"	"	"	"	7	15.2	14.4	86.9
" " "	"	"	"	"	"	"	"	11	14.3	13.6	85.1
" " "	"	"	"	"	"	"	"	8	15.1	14.3	84.3
Edwin Holloway, Wana.....	Vilmorin Amelioree..	Apr. 21	"	Sandy.....	10 in.	12 tons	Nothing.....	4	7	12.0	88.9
" " "	"	"	"	"	"	"	"	5	12	7.7	63.2
" " "	Klein Wanzlebener..	"	"	"	"	"	"	1	12	7.3	80.9
" " "	"	"	"	"	"	"	"	1	12	11.7	64.9
" " "	Le Maire.....	"	"	"	"	"	"	1	8	12.8	80.2
" " "	"	"	"	"	"	"	"	1	6	13.0	34.2
" " "	Vilmorin Improved.....	"	"	"	"	"	"	1	15	14.7	85.0
" " "	"	"	"	"	"	"	"	1	15	14.7	87.5
" " "	"	"	"	"	"	"	"	1	9	12.8	84.8
" " "	"	"	"	"	"	"	"	1	3	11.0	80.9
" " "	"	"	"	"	"	"	"	3	8	10.9	79.6
" " "	"	"	"	"	"	"	"	3	15	11.0	78.0

Price Cunningham, Welch.....	May 7	Oct. 12	Sandy loam.....	10 in.	10 tons	Corn.....	13	15.8	15.0	86.8	
Vilmorin Ameliorée.....	"	"	"	"	"	"	10	15.2	14.4	84.0	
Le Maire.....	"	"	"	"	"	"	15	16.2	15.4	84.8	
Klein Wanzleben.....	"	"	"	"	"	"	10	18.3	17.4	88.4	
Vilmorin Richet.....	"	"	"	8 in.	"	Potatoes.....	10	15.3	14.5	82.7	
"	"	"	"	"	"	"	13	12.4	11.8	71.6	
Vilmorin Ameliorée.....	"	"	"	"	"	"	5	13.9	13.2	74.3	
"	"	"	"	"	"	"	12	15.8	15.0	79.8	
Le Maire.....	May 10	Oct. 11	"	7 in.	"	Lettuce.....	15	16.5	15.7	82.1	
Vilmorin Ameliorée.....	"	"	"	"	"	"	14	17.5	16.6	89.9	
"	"	"	"	"	"	"	1	11	16.3	86.7	
Vilmorin Ameliorée.....	"	"	"	"	"	"	9	18.1	17.2	87.4	
Klein Wanzleben.....	"	"	"	"	"	"	11	17.5	16.6	87.5	
"	"	"	"	"	"	"	13	13.3	12.6	72.3	
Vilmorin Ameliorée.....	"	Oct. 12	"	"	"	Onions.....	1	4	12.9	12.3	75.8
"	"	"	"	"	"	"	12	14.9	14.2	73.0	
Vilmorin Ameliorée.....	"	"	"	"	"	"	14	17.0	16.2	83.7	
Vilmorin Improved.....	"	"	"	"	"	"	15	14.0	13.3	77.8	
Le Maire.....	May 26	"	Black loam.....	6 in.	"	Potatoes.....	1	1	16.5	14.7	78.3
"	"	"	"	"	"	"	1	1	15.5	15.7	85.5
Mette.....	"	"	"	"	"	"	1	1	15.6	14.7	80.3
Klein Wanzleben.....	"	"	"	"	"	"	1	1	15.8	15.0	82.3
"	"	"	"	"	"	"	1	4	15.4	14.6	81.5
"	"	"	"	"	"	"	13	15.7	14.9	83.9	
Le Maire.....	May 20	Oct. 11	Upland.....	8 in.	"	"	1	9	14.6	13.9	80.7
Klein Wanzleben.....	"	"	"	"	"	"	8	13.0	12.4	72.6	
Vilmorin Ameliorée.....	"	"	"	"	"	"	2	14.9	14.2	76.8	
"	"	"	"	"	"	"	1	2	14.7	14.0	82.1
"	"	"	"	"	"	"	1	7	14.1	13.4	76.7
"	"	"	"	"	"	"	9	14.4	13.7	78.3	
Mette.....	"	"	"	"	"	"	2	6	15.2	14.4	80.8
Vilmorin Improved.....	"	"	"	"	"	"	1	14	16.2	15.4	83.9
Mette.....	"	"	"	"	"	"	3	9	13.3	12.6	76.5
Vilmorin Ameliorée.....	May 1	Oct. 15	Dark loam.....	10 in.	"	Potatoes.....	2	16.1	15.3	82.6	
"	"	"	"	"	"	"	3	4	17.1	16.2	85.1
Vilmorin Ameliorée.....	Apr. 27	Oct. 17	"	12 in.	"	Cabbage.....	2	5	17.6	16.7	83.4
Le Maire.....	"	"	"	"	"	"	1	9	17.0	16.2	83.7
Klein Wanzleben.....	"	"	"	"	"	"	2	5	16.7	15.9	84.3
"	"	"	"	"	"	"	2	3	17.8	16.9	88.5
Unknown.....	"	"	"	"	"	"	1	14	14.9	14.2	78.4
Vilmorin Ameliorée.....	Apr. 30	"	"	6 in.	20 tons	Potatoes.....	2	11	16.8	16.0	81.6
"	"	"	"	"	"	"	2	14	13.4	12.7	75.3
Le Maire.....	"	"	"	"	"	"	2	14	16.0	15.2	80.4
"	"	"	"	"	"	"	2	7	14.8	14.1	82.7
"	"	"	"	"	"	"	2	9	15.9	15.1	81.5
"	"	"	"	"	"	"	4	4	14.5	13.8	78.8
"	"	"	"	"	"	"	3	13	14.9	14.2	80.5
"	"	"	"	"	"	"	2	10	15.1	14.3	80.7

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONTINUED.

<i>Name of grower and postoffice address.</i>	<i>Variety of beets grown.</i>	<i>Date of planting.....</i>	<i>Date of harvesting</i>	<i>Character of soil</i>	<i>Depth of plowing.....</i>	<i>Estimated yield per acre</i>	<i>Crop grown on same ground the preceding year</i>	<i>Weight of beet.....</i>	<i>Sugar in juice..</i>	<i>Sugar in beet....</i>	<i>Purity.....</i>
L. Tanfen, Uniontown	Mette.....	May 15	Oct. 17	Black loam.....	5 in.	2 tons	Potatoes	lbs. oz.	14.8	14.1	80.9
" " "	Klein Wanzelebener	"	"	"	"	"	"	3 14	14.1	14.1	77.5
" " "	"	"	"	"	"	"	"	3 7	14.1	13.4	77.5
Theo. Goedde, Uniontown	Mette.....	May 15	Oct. 17	Black loam.....	5 in.	2 tons	Potatoes	3 11	14.1	14.1	74.6
" " "	"	"	"	"	"	"	"	2 5	14.3	13.6	77.7
T. Heitstmann, " "	Vilmorin Improved	"	"	"	"	"	"	2 4	14.3	13.6	77.7
" " "	"	"	"	"	"	"	"	2 1	13.8	13.1	68.6
" " "	"	"	"	"	"	"	"	2 15	14.1	13.4	77.1
" " "	"	"	"	"	"	"	"	1 12	15.8	15.0	84.5
Paul Tuchs, " "	Klein Wanzelebener	"	"	"	"	"	"	1 3	17.9	17.0	88.1
" " "	"	"	"	"	"	"	"	2 2	14.7	13.3	81.4
" " "	"	"	"	"	"	"	"	2 15	14.0	14.0	82.1
" " "	Vilmorin Ameliorée.	Apr. 28	Oct. 17	Black loam.....	8 in.	"	Potatoes	2 13	13.8	13.1	78.9
" " "	"	"	"	"	"	"	"	3 13	15.1	14.3	79.1
Jacob Kinzer, " "	Le Maire.	May 1	"	"	"	2 tons	"	3 8	14.1	13.4	77.1
" " "	Mette.....	"	"	"	"	"	"	2 2	12.7	12.1	72.5
" " "	"	"	"	"	"	"	"	2 2	13.7	13.0	75.2
" " "	"	"	"	"	"	"	"	2 4	13.9	13.2	74.7
" " "	"	"	"	"	"	"	"	14	17.2	16.3	83.1
W. A. Myers, " "	"	"	"	"	"	4 tons	Wheat.	14	16.3	13.0	80.1
" " "	"	"	"	"	"	"	"	13	13.7	15.5	82.3
John and Will Luy, Uniontown.	Unknown	May 15	"	Black loam.....	8 in.	"	"	2 13	17.1	16.2	85.1
" " "	"	"	"	"	"	"	"	1 9	15.8	15.0	82.7
V. Mayers, Uniontown	Mette.....	"	"	"	"	"	"	2 6	15.7	14.9	82.6
" " "	"	"	"	"	"	"	"	2 12	14.2	13.5	81.1
J. N. Marlatt, " "	"	"	"	"	"	"	"	2 1	14.3	13.6	79.9
" " "	"	"	"	"	"	"	"	2 1	17.3	16.4	84.4
F. E. Deeringhoff, Uniontown	Klein Wanzelebener	Apr. 30	"	"	6 in.	25 tons	Nothing	2 1	17.3	16.4	84.4
" " "	Red Vilmorin	"	"	"	"	"	"	1 6	17.3	16.4	86.5
" " "	"	"	"	"	"	"	"	1 2	15.0	14.3	85.2
Unknown, Uniontown	Unknown	"	"	"	"	"	"	2 2	16.0	15.2	86.5
" " "	Le Maire.	"	"	"	"	"	"	2 10	11.2	10.6	75.7
" " "	Unknown	"	"	"	"	"	"	5	18.0	17.1	78.3
" " "	"	"	"	"	"	"	"	11	21.1	20.0	89.0
" " "	"	"	"	"	"	"	"	14	18.2	17.3	82.3
" " "	"	"	"	"	"	"	"	8	17.9	17.0	81.7
" " "	"	"	"	"	"	"	"	8	16.0	15.2	71.8
" " "	"	"	"	"	"	"	"	8	16.9	16.1	81.6

Unknown	Unknown	June 1	Oct. 20	Black loam.	8 in.	2 tons	Wheat.	11	18.0	17.1	84.9
"	"	"	"	"	"	"	"	2	17.1	16.2	81.0
"	"	"	"	"	"	"	"	8	17.2	16.3	96.1
"	"	"	"	"	"	"	"	9	13.0	12.4	83.9
"	"	"	"	"	"	"	"	10	19.0	18.1	87.1
"	"	"	"	"	"	"	"	12	19.2	18.2	88.1
"	"	"	"	"	"	"	"	11	19.5	18.5	83.0
"	"	"	"	"	"	"	"	12	21.3	20.2	90.0
"	"	"	"	"	"	"	"	12	17.8	16.9	80.9
"	"	"	"	"	"	"	"	13	18.6	17.7	81.2
"	"	"	"	"	"	"	"	10	18.9	18.0	81.4
"	"	"	"	"	"	"	"	10	21.5	20.4	90.7
R. J. Watson, Palouse.	Le Maire.	June 1	Oct. 20	Black loam.	8 in.	2 tons	Wheat.	6	16.8	16.0	86.2
"	"	"	"	"	"	"	"	6	15.2	14.4	83.1
"	Vilmorin Amelioree.	"	"	"	"	"	"	10	14.2	13.5	86.5
"	"	"	"	"	"	"	"	10	13.7	13.0	91.3
Unknown.	Unknown.	"	"	"	"	"	"	11	14.8	14.1	75.1
Christian Sclonaker, Palouse.	Mette.	June 1	"	"	10 in.	"	Garden.	1	13	15.1	75.8
"	"	"	"	"	"	"	"	5	15.2	14.4	81.3
D. W. Twietmyer,	Unknown.	"	"	"	"	"	"	9	14.1	13.4	84.9
"	"	"	"	"	"	"	"	12	15.7	14.9	85.8
Unknown, Palouse.	"	"	"	"	"	"	"	6	14.5	13.8	76.3
Geo. W. Harvey, Harvey.	Vilmorin Improved.	May 25	Sept. 15	Black loam.	6 in.	"	Potatoes	1	15	17.5	83.6
"	"	"	"	"	"	"	"	1	10	14.0	83.3
E. F. Shanon,	Klein Wanzlebener.	"	"	"	"	"	"	1	10	15.5	14.7
"	Le Maire.	"	"	"	"	"	"	2	8	12.0	71.4
"	"	"	"	"	"	"	"	1	7	16.2	15.4
C. H. Chamberlain, Harvey.	Vilmorin Amelioree.	May 15	Oct. 12	Black loam.	7 in.	"	Potatoes	1	4	16.5	80.9
"	Klein Wanzlebener.	"	"	"	"	"	"	1	5	16.7	15.7
"	Vilmorin Amelioree.	"	"	"	"	"	"	1	4	17.0	16.2
A. Cullen, Ellensburg.	Le Maire.	May 28	Oct. 15	Sandy loam.	8 in.	"	Wheat.	1	2	17.7	86.3
"	"	"	"	"	"	"	"	6	17.2	16.3	96.6
"	Vilmorin Amelioree.	"	"	"	"	"	"	9	18.6	17.7	90.4
F. D. and C. P. Schnebly, Harvey.	Klein Wanzlebener.	May 25	"	"	7 in.	"	Potatoes	12	18.4	17.5	92.0
"	"	"	"	"	"	"	"	12	14.8	14.1	81.8
"	Vilmorin Amelioree.	"	"	"	"	"	"	15	17.6	16.7	88.8
"	Le Maire.	"	"	"	"	"	"	10	18.6	17.7	92.1
"	"	"	"	"	"	"	"	8	17.6	16.7	90.0
"	Vilmorin Amelioree.	"	"	"	"	"	"	1	3	17.4	16.5
"	Le Maire.	"	"	"	"	"	"	1	3	16.4	15.6
"	"	"	"	"	"	"	"	2	5	15.5	14.7
J. W. Darland, Pullman.	Klein Wanzlebener.	"	Oct. 18	Clay loam.	9 in.	"	"	3	15.7	14.9	79.9
"	"	"	"	"	"	"	"	3	14.6	13.8	83.4
"	Vilmorin Amelioree.	"	"	"	"	"	"	1	14	16.6	15.8
"	Le Maire.	"	"	"	"	"	"	1	4	17.4	16.5
"	"	"	"	"	"	"	"	1	4	16.3	85.3
"	"	"	"	"	"	"	"	1	12	14.6	78.9
S. S. Martin, Starbuck.	Klein Wanzlebener.	Apr. 15	"	Creek bottom.	12 in.	"	Wheat	1	2	13.2	77.2

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON — CONTINUED.

Name of grower and postoffice address.	Variety of beets grown.	Date of plant- ing.....	Date of har- vesting	Character of soil	Depth of plowing	Estimated yield per acre	Crop grown on same ground the preceding year	Weight of beet.....	Sugar in juice..	Sugar in beet...	Purity.....
								lbs. oz.			
S. S. Martin, Starbuck.....	Klein Wanzlebener.....	Apr. 15		Cr'k bottom.....	12 in.		Wheat ..	13	12.4	11.8	72.1
" " " ".....	Vilmorin Ameloree.....	"		" " " ".....	"		" " " ".....	14	13.7	13.0	73.2
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	1	9	11.4	70.3
" " " ".....	Le Maire.....	"		" " " ".....	"		" " " ".....	1	1	15.3	78.5
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	1	2	17.0	84.6
P. Murray, Elma	Klein Wanzlebener.....	May 4		Sandy loam.....	10 in.		Potatoes.....	3	8	13.0	81.8
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	3	1	11.5	79.3
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	1	1	14.2	84.0
J. B. Biles,	Vilmorin Ameloree.....	May 12		" " " ".....	"		Garden.....	1	13	13.0	83.3
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	1	18	12.4	78.9
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	2	4	13.1	80.9
" " " ".....	Le Maire.....	"		" " " ".....	"		" " " ".....	2	10	11.9	80.9
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	3	3	12.0	80.5
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	1	15	13.0	83.9
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	2	4	13.5	78.9
" " " ".....	Klein Wanzlebener.....	"		" " " ".....	"		" " " ".....	1	6	14.1	80.1
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	1	9	15.0	80.6
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	2	1	13.4	72.0
" " " ".....	Vilmorin Ameloree.....	"		" " " ".....	"		" " " ".....	1	2	13.7	75.7
" " " ".....	" " " ".....	"		" " " ".....	"		" " " ".....	1	3	14.8	74.0
P. D. Sardam, Palouse.....	Klein Wanzlebener.....	May 15	Oct. 22	Black loam.....	8 in.		Potatoes.....	2	5	14.9	82.8
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	1	6	18.6	85.6
E. W. Livermore, Wickersham ..	Le Maire.....	May 12	Oct. 11	Gravelly f'm.....	"		Carrots.....	1	1	13.2	81.0
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	1	8	12.9	75.0
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	1	3	13.3	77.4
" " " ".....	Klein Wanzlebener.....	"	"	" " " ".....	"		" " " ".....	11	12.3	11.7	79.3
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	9	13.7	13.0	83.0
" " " ".....	Vilmorin Ameloree.....	"	"	" " " ".....	"		" " " ".....	6	12.0	11.4	87.0
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	12	13.6	12.9	84.5
E. A. Bryan, Pullman.....	Unknown.....	"	"	" " " ".....	"		" " " ".....	1	9	14.0	83.3
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	15	14.1	13.4	86.0
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	13	14.5	13.8	85.3
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	14	15.7	14.9	77.7
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	18	14.2	13.5	82.1
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	1	6	14.2	84.0
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	1	7	14.3	80.3
" " " ".....	" " " ".....	"	"	" " " ".....	"		" " " ".....	1	3	14.6	84.9

[illegible]

J. D. Smith, Dayton	Le Maire.....	Apr. 15	Black loam.....	9 in.	9 tons	Nothing.....	1	14	17.3	16.4	85.6
"	Vilmorin Amelioree..	"	"	"	"	"	"	13	17.4	16.5	86.1
J. P. McLarry,	"	May 4	Oct. 12	8 in.	"	Garden	2	13	16.7	15.9	86.5
"	Klein Wanzlebener..	"	"	"	"	"	"	15	15.4	14.6	80.2
"	"	"	"	"	"	"	"	15	16.4	15.6	79.2
Geo. Barclay,	Vilmorin Improved..	"	"	"	"	"	1	11	11.6	11.0	64.8
"	"	"	"	"	"	"	3	4	13.8	13.1	72.2
"	"	"	"	"	"	"	3	4	7.2	6.8	62.0
"	"	"	"	"	"	"	3	7	7.0	6.7	62.5
J. E. Gaines,	Vilmorin Amelioree..	Apr. 20	Oct. 13	9 in.	6 tons	Corn.....	7	15.1	14.3	84.3	
"	"	"	"	"	"	"	6	17.0	16.2	86.7	
"	Klein Wanzlebener..	"	"	"	"	"	5	18.0	17.1	88.6	
"	"	"	"	"	"	"	8	18.3	17.4	92.4	
"	Le Maire.....	"	"	"	"	"	6	16.5	15.7	85.5	
"	"	"	"	"	"	"	5	17.0	16.2	89.5	
G. F. Bottorff, Kettle Falls.	Klein Wanzlebener..	Oct. 27	6 in.	"	"	Nothing	14	16.0	15.2	85.6	
"	"	"	"	"	"	"	12	15.2	14.4	84.4	
"	Vilmorin Amelioree..	"	"	"	"	"	9	16.0	15.2	87.4	
"	"	"	"	"	"	"	9	15.1	14.3	88.8	
"	Le Maire.....	"	"	"	"	"	7	15.6	14.8	86.2	
"	"	"	"	"	"	"	8	13.8	13.1	76.7	
Edwin Bottorff,	Mette	June 1	Calcareous.....	5 in.	"	"	1	2	17.1	16.2	89.1
"	"	"	"	"	"	"	1	2	15.7	14.9	82.2
David Weaver, Cheney.	Vilmorin Amelioree..	"	"	"	"	"	1	1	14.7	14.0	71.7
"	"	"	"	"	"	"	2	1	15.6	14.8	79.6
"	"	"	"	"	"	"	2	1	13.9	13.2	74.3
"	"	"	"	"	"	"	1	9	15.5	14.7	79.9
A. J. Ottomeier,	Mette	Apr. 15	Sandy loam.....	6 in.	"	Wheat.....	2	8	15.7	14.9	83.1
"	"	"	"	"	"	"	3	3	14.0	13.3	82.3
"	Klein Wanzlebener..	"	"	"	"	"	2	12	17.2	16.3	78.0
"	"	"	"	"	"	"	3	7	16.9	16.1	86.2
John F. Clizer, Latah.	"	May 1	Black loam.....	"	"	Barley	1	7	15.4	14.6	81.0
"	"	"	"	"	"	"	1	13	16.3	15.5	84.4
"	Vilmorin Amelioree..	"	"	"	"	"	1	4	16.0	15.2	82.9
"	"	"	"	"	"	"	1	3	15.0	14.3	83.8
"	Le Maire.....	"	"	"	"	"	1	15	14.0	13.3	81.4
"	"	"	"	"	"	"	2	6	15.5	14.7	83.8
Geo. C. Miller,	Klein Wanzlebener..	May 19	"	9 in.	"	Corn.....	1	8	14.8	14.1	74.0
"	"	"	"	"	"	"	1	3	17.0	16.2	82.5
"	Vilmorin Improved..	"	"	"	"	"	2	4	13.5	12.8	84.9
"	"	"	"	"	"	"	2	12	11.0	10.5	77.5
Robert Tinling, Acme.	"	May 10	Gravly loam.....	"	20 tons	Potatoes	1	15	10.6	10.1	81.8
"	"	"	"	"	"	"	1	14	8.2	7.8	73.2
"	"	"	"	"	"	"	2	4	9.7	9.2	80.9
"	"	"	"	"	"	"	2	10	9.8	9.3	85.2
T. J. Patterson, Hartford.	Mette	May 22	"	12 in.	"	Nothing.....	1	8	11.0	10.5	80.9
"	"	"	"	"	"	"	4	12.9	12.3	83.2	
"	"	"	"	"	"	"	5	17.0	16.2	92.4	

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONTINUED.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.	Date of harvesting.	Character of soil.	Depth of plowing.	Estimated yield per acre.	Crop grown on same ground the preceding year.	Weight of beet.	Sugar in juice.	Sugar in beet.	Purity.
August Benson, Hartford.	Klein Wanzlebener.	May 10	Oct. 22	Upland.	12 in.		Potatoes.	1 1	13.7	13.0	85.2
" " "	" "	"	"	"	"		"	3	15.9	15.1	90.8
" " "	Le Maire.	"	"	"	"		"	1	13.8	13.1	84.7
" " "	Vilmorin Ameliorée.	"	"	"	"		"	1	14.9	14.2	88.1
" " "	"	"	"	"	"		"	11	15.0	14.3	85.7
" " "	"	"	"	"	"		"	12	15.0	14.3	87.7
Unknown,	Unknown.	May 12	Oct. 20	Sandy loam.	10 in.		Carrots.	11	16.4	15.6	87.2
F. D. Ball, Palouse.	Klein Wanzlebener.	"	"	"	"		"	12	15.8	15.0	81.5
" " "	"	"	"	"	"		"	9	16.7	15.9	82.3
" " "	"	"	"	"	"		"	8	17.4	16.5	84.4
" " "	"	"	"	"	"		"	8	15.0	14.3	82.4
" " "	"	"	"	"	"		"	1	12.9	12.3	81.1
" " "	"	"	"	"	"		"	13	15.7	14.9	80.1
" " "	"	"	"	"	"		"	6	17.3	16.4	85.2
" " "	"	"	"	"	"		"	11	16.9	16.1	86.2
John G. Chappell, Beach.	Vilmorin Improved.	"	Oct. 18	Clay	18 in.	20 tons	Nothing.	1	9	10.8	76.1
" " "	"	"	"	"	"	"	"	1	5	11.5	79.9
M. C. Moore, Walla Walla.	"	"	"	Volcanic ash.	6 in.	"	Carrots.	3	4	7.0	49.6
" " "	"	"	"	"	"	"	"	3	8	8.0	58.8
Philip Yenny,	"	"	"	"	"	"	"	3	7	10.4	68.4
" " "	"	"	Oct. 20	Sandy loam.	12 in.	"	Corn.	4	12.0	11.4	75.0
" " "	"	"	"	"	"	"	"	5	10.9	10.4	71.2
W. W. Baker,	"	"	"	"	"	"	"	8	11.2	10.6	75.7
" " "	"	"	"	"	"	"	Potatoes.	8	11.4	10.8	75.0
H. Parker,	"	"	"	Dark	8 in.	"	"	15	15.6	14.8	82.5
" " "	Mette.	"	"	"	"	"	"	7	17.5	16.6	81.8
" " "	"	"	"	"	"	"	"	8	16.6	15.8	87.8
W. P. Reser,	"	Apr. 20	Oct. 20	"	"	10 tons	Potatoes.	5	4	12.8	76.2
" " "	"	"	"	"	"	"	"	8	11.6	11.0	75.3
Ed. Reser,	"	"	"	"	10 in.	"	"	1	11	12.6	80.3
" " "	"	"	"	"	"	"	"	1	9	13.8	84.1
Fred. Kiens,	Knauer's Imperial.	May 10	Oct. 12	Sandy loam.	7 in.	15 tons	Potatoes.	1	6	14.2	85.5
" " "	"	"	"	"	"	"	"	2	8	13.1	74.9
John Kiens,	"	May 12	"	"	6 in.	14 tons	Cabbages.	1	7	12.5	78.7
" " "	"	"	"	"	"	"	"	1	10	13.6	81.0

Truls Hansen, Sedro.....	May 19	Oct. 12	Black muck.....	6 in.	12 tons	Carrots.....	1	10	13.3	12.6	81.6
"	"	"	"	"	"	"	1	2	13.4	12.7	79.3
J. M. Harrison, Sedro.....	May 9	"	Sandy loam.....	8 in.	10 tons	Mangels.....	1	13	13.5	12.7	79.3
"	"	"	"	"	"	"	1	1	13.2	12.5	81.0
K. H. A. Polte,.....	May 18	"	Black muck.....	"	11 tons	Potatoes.....	1	1	13.2	12.5	80.0
"	"	"	"	"	"	"	1	12	14.0	13.3	79.1
Vilmorin Amelioree.....	May 1	"	Sandy loam.....	"	"	"	2	11	12.3	11.7	78.9
"	"	"	"	"	"	"	1	5	13.4	12.7	79.3
H. Conaway, Napavine.....	"	"	"	"	"	"	1	15	15.8	15.0	86.3
"	"	"	"	"	"	"	1	11	14.8	14.1	81.8
"	"	"	"	"	"	"	1	15	14.3	13.6	84.6
Vilmorin Amelioree.....	"	"	"	"	"	"	2	8	12.7	12.1	79.9
"	"	"	"	"	"	"	1	9	13.6	12.9	81.4
Klein Wanzlebener.....	"	"	"	"	"	"	1	5	13.5	12.8	82.3
"	"	"	"	"	"	"	1	5	13.5	12.8	82.3
"	"	"	"	"	"	"	1	13	13.1	12.4	79.4
Ira Johnson,.....	"	"	"	"	"	"	1	11	14.0	13.3	84.8
"	"	"	"	"	"	"	1	11	14.0	13.3	84.8
Frank Drabek, Chehalis.....	May 10	Oct. 19	Black loam.....	8 in.	"	Oats.....	1	2	13.0	12.6	79.2
"	"	"	"	"	"	"	1	2	13.0	12.4	78.3
"	"	"	"	"	"	"	2	5	12.9	12.3	78.7
"	"	"	"	"	"	"	1	1	12.1	11.5	74.7
"	"	"	"	"	"	"	2	2	12.9	12.3	81.1
"	"	"	"	"	"	"	1	6	12.7	12.1	76.9
J. J. C. Bush,.....	May 13	Oct. 20	"	"	15 tons	Vegetables.....	1	14	11.7	11.1	80.7
"	"	"	"	"	"	"	1	6	12.5	11.9	78.7
L. W. Kaylor, Napavine.....	May 10	Oct. 18	Sandy loam.....	10 in.	6 tons	Peas.....	1	14	11.5	10.9	76.7
"	"	"	"	"	"	"	2	10	12.0	11.4	75.0
"	"	"	"	"	"	"	1	10	13.3	12.6	83.6
Peter Woods, Elma.....	Apr. 25	Oct. 13	Clay soil.....	8 in.	"	Potatoes.....	2	2	12.7	12.1	71.8
"	"	"	"	"	"	"	1	9	13.5	12.8	76.7
"	"	"	"	"	"	"	1	4	12.2	11.6	72.6
"	"	"	"	"	"	"	1	14	11.6	11.0	73.0
Geo. E. Smith, Sprague.....	Apr. 10	Oct. 12	Hill land.....	10 in.	"	Garden.....	8	15	15.5	14.7	75.6
"	"	"	"	"	"	"	7	15	13.5	14.5	69.2
"	"	"	"	"	"	"	7	7	13.0	12.4	58.0
Rud Kiesling, Spokane.....	May 11	Oct. 20	Black loam.....	8 in.	22 tons	Potatoes.....	2	8	14.1	13.4	75.4
"	"	"	"	"	"	"	2	8	12.6	12.0	76.8
"	"	"	"	"	"	"	1	12	14.0	13.3	76.5
"	"	"	"	"	"	"	1	14	16.5	15.7	81.7
B. O. Coleman, Rockford.....	"	Oct. 22	Clay.....	4 in.	"	Nothing.....	1	4	13.5	12.8	76.7
"	"	"	"	"	"	"	1	15	13.1	12.4	78.9
"	"	"	"	"	"	"	9	13.5	12.8	78.9	75.9
"	"	"	"	"	"	"	12	13.8	13.1	83.6	88.4
A. Lashon,.....	"	"	"	"	"	"	8	13.7	13.0	88.4	88.4
"	"	"	"	"	"	"	10	12.9	12.3	83.8	83.8
"	"	"	"	"	"	"	11	15.1	14.3	86.8	86.8
"	"	"	"	"	"	"	1	2	13.7	13.0	82.5
"	"	"	"	"	"	"	3	3	11.6	11.0	74.8
D. W. Bridgman, Latah.....	"	"	"	"	"	"	5	5	14.2	13.5	82.1

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONTINUED.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.....	Date of harvesting	Character of soil.....	Depth of plowing.....	Estimated yield per acre.....	Crop grown on same ground the preceding year.....	Weight of beet..... lbs. oz.	Sugar in juice..	Sugar in beet...	Purity.....
D. W. Bridgman, Latah.	Unknown.	.....	.....	.....	.....	.....	.....	1 15	15.6	14.8	89.7
"	"	.....	.....	.....	.....	.....	.....	1 1	14.8	14.1	86.5
"	"	.....	.....	.....	.....	.....	.....	2	12.5	11.9	79.1
"	"	.....	.....	.....	.....	.....	.....	13	15.8	15.0	85.4
"	"	.....	.....	.....	.....	.....	.....	1 13	12.4	11.8	83.8
"	"	.....	.....	.....	.....	.....	.....	1 7	14.1	13.4	86.4
"	"	.....	.....	.....	.....	.....	.....	8	15.9	15.1	84.1
"	"	.....	.....	.....	.....	.....	.....	15	14.9	14.2	81.4
J. S. Klenigard, Pullman.	Knauer's Imperial.	May 9	Oct. 28	Black loam.	9 in.	.....	Potatoes.	12	15.6	14.8	83.0
"	"	.....	.....	"	"	.....	"	8	16.2	15.4	79.4
"	"	.....	.....	"	"	.....	"	2	16.1	15.3	81.3
"	"	.....	.....	"	"	.....	"	1 5	15.2	14.4	80.4
"	"	.....	.....	"	"	.....	"	1 2	15.1	14.3	80.3
"	"	.....	.....	"	"	.....	"	1 3	14.9	14.2	81.0
J. W. Gantz, Dayton.	Vilmorin Ameloree.	May 20	Oct. 13	"	10 in.	.....	Wheat.	1 8	14.6	13.9	84.4
"	"	.....	.....	"	"	.....	"	1 10	16.9	16.1	84.9
"	"	.....	.....	"	"	.....	"	2	12	17.0	86.7
"	"	.....	.....	"	"	.....	"	1 14	17.4	16.5	84.9
"	"	.....	.....	"	"	.....	"	15	19.4	18.4	85.4
"	"	.....	.....	"	"	.....	"	11	18.5	17.6	88.1
Unknown,	Unknown.	.....	.....	"	"	.....	"	11	18.6	17.7	88.6
"	"	.....	.....	"	"	.....	"	8	19.9	18.9	93.0
"	"	.....	.....	"	"	.....	"	9	21.1	20.0	93.3
"	"	.....	.....	"	"	.....	"	13	17.6	16.7	90.0
"	"	.....	.....	"	"	.....	"	8	16.6	15.8	87.8
"	"	.....	.....	"	"	.....	"	12	19.5	18.5	97.5
"	"	.....	.....	"	"	.....	"	1	15.5	14.7	84.2
Elmer H. Brown, Dayton.	Vilmorin Improved.	.....	Oct. 13	Sandy	8 in.	.....	Potatoes.	15	14.2	13.5	79.3
"	"	.....	.....	"	"	.....	"	1 11	14.0	13.3	81.9
"	"	.....	.....	"	"	.....	"	1 9	11.5	10.9	74.2
J. H. Ingram,	"	.....	.....	"	"	.....	"	3	14	16.0	81.2
"	"	.....	.....	"	"	.....	"	2	9	13.4	76.1
Alice Barbee, Pullman.	Unknown.	.....	.....	Bottom land.	.....	.....	.....	8	16.7	15.9	89.7
"	"	.....	.....	"	.....	.....	"	14	15.8	15.0	91.9
A. G. Jacobson, Hartford.	Le Maire.	Mar. 20	Oct. 28	Sandy loam.	12 in.	.....	Potatoes.	1 3	15.4	14.6	90.6
"	"	.....	.....	"	"	.....	"	1 15	13.0	12.4	90.9
"	"	"	"	"				

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONTINUED.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.....	Date of harvesting.....	Character of soil.....	Depth of plowing.....	Estimated yield per acre.....	Crop grown on same ground the preceding year.....	Weight of beet..... lbs. oz.	Sugar in juice..	Sugar in beet...	Purity.....
B. F. Jenkins, Kalama	Klein Wanzlebener..	June 4	Oct. 12	Dark loam...	12 in.	.....	Cabbage.....	1 9	13.5	12.8	87.1
Andrew Smith, Whatcom.....	Vilmorin Improved..	"	"	"	"	.....	"	2 1	11.5	10.9	78.7
"	Mette.....	"	"	"	"	.....	"	4 4	12.7	12.1	80.9
J. D. Rodenberger, Whatcom.....	Klein Wanzlebener..	May 15	"	"	"	.....	Carrots.....	1 3	10.2	9.7	76.1
"	"	"	"	"	"	.....	"	1 4	9.0	8.6	69.2
"	Le Maire.....	"	"	"	"	.....	"	12 11.4	10.8	76.5	75.5
"	"	"	"	"	"	.....	"	1 5	11.7	11.1	75.5
"	Vilmorin Ameloree..	"	"	"	"	.....	"	2 7	13.2	12.5	81.5
"	"	"	"	"	"	.....	"	1 4	13.6	10.8	76.5
H. A. Dyven, Whatcom.....	"	May 23	Oct. 9	Beaver m'ish..	8 in.	.....	Potatoes.....	7 4	13.6	12.9	79.5
"	Le Maire.....	"	"	"	"	.....	"	7 11.7	11.7	11.1	79.6
"	Klein Wanzlebener..	"	"	"	"	.....	"	6 12.0	11.4	11.4	78.9
John Stijn, Reardon.....	Vilmorin Richest.....	June 8	Oct. 20	Black loam...	16 in.	.....	"	8 12.8	12.2	82.6	82.6
"	"	"	"	"	"	.....	"	13 14.3	13.6	81.7	81.7
"	Vilmorin Ameloree..	"	"	"	"	.....	"	13 17.5	16.6	90.6	90.6
"	"	"	"	"	"	.....	"	14 16.8	16.0	88.0	88.0
"	"	"	"	"	"	.....	"	14 17.8	16.9	83.2	83.2
Andrew Gray, Reardon.....	Vilmorin Richest.....	May 15	"	"	8 in.	25 tons	Wheat.....	1 12	17.2	16.3	86.0
"	"	"	"	"	"	.....	"	1 12	15.0	14.3	86.0
"	"	"	"	"	"	.....	Garden.....	1 8	16.2	15.4	77.7
"	"	"	"	"	"	.....	"	1 15	17.0	16.2	89.5
"	Vilmorin Ameloree..	"	"	"	"	.....	"	1 16.8	16.0	84.0	91.9
"	"	"	"	"	"	.....	"	1 12	17.0	16.2	86.3
"	"	"	"	"	"	.....	Wheat.....	2 7	15.3	14.5	75.0
"	"	"	"	"	"	.....	"	2 16.0	15.2	82.9	82.9
James Leslie,	Klein Wanzlebener..	May 9	"	Light loam...	7 in.	.....	Potatoes.....	1 3	14.3	13.6	71.1
"	"	"	"	"	"	.....	"	1 8	17.9	17.0	86.9
"	Le Maire.....	"	"	"	"	.....	"	1 16.0	15.2	86.0	86.0
"	"	"	"	"	"	.....	"	1 15	16.5	15.7	85.5
"	Vilmorin Ameloree..	"	"	"	"	.....	"	1 4	17.0	16.2	83.3
"	"	"	"	"	"	.....	"	1 14	17.5	16.6	88.8
E. H. Morrison, Fairfield.....	Klein Wanzlebener..	Apr. 27	Oct. 10	Dark loam...	12 in.	18 tons	"	8 17.1	16.2	88.5	88.5
"	"	"	"	"	"	.....	"	8 17.0	16.2	90.9	90.9
"	"	"	"	"	"	.....	"	7 15.9	15.1	91.9	91.9
"	"	"	"	"	"	.....	"	1 11	12.2	11.6	80.3
A. H. Bailey, Marysville	"	May 10	Oct. 13	Sandy loam...	6 in.	13 tons	Nothing.....	2 2	13.2	12.5	77.6

A. H. Bailey, Marysville	Klein Wanzlebener	May 10	Oct. 13	Sandy loam	6 in.	13 tons	Nothing	2	1	14.0	13.3	81.4
H. B. Myers	"	"	"	"	"	"	"	1	9	11.1	10.5	72.6
Horace Clingman, Fairfield	Vilmorin Improved	"	"	"	"	"	"	1	10	12.7	12.1	72.2
"	"	"	"	"	"	"	"	1	9	11.8	11.2	71.9
"	"	"	"	"	"	"	"	1	15	10.3	9.8	72.0
E. H. Morrison	Klein Wanzlebener	Apr. 27	Oct. 10	Dark loam	12 in.	18 tons	"	1	4	11.1	10.5	66.8
"	"	"	"	"	"	"	"	11	13.0	12.4	78.8	
"	"	"	"	"	"	"	"	10	15.3	14.5	84.5	
"	"	"	"	"	"	"	"	8	15.5	14.7	89.0	
"	"	"	"	"	"	"	"	11	14.6	13.9	85.4	
"	"	"	"	"	"	"	"	6	16.3	15.5	90.0	
"	"	"	"	"	"	"	"	9	17.0	16.2	92.4	
"	"	"	"	"	"	"	"	7	14.3	13.6	85.6	
"	"	"	"	"	"	"	"	13	14.3	13.6	84.1	
"	"	"	"	"	"	"	"	14	15.7	14.9	86.7	
"	"	"	"	"	"	"	"	15	15.4	14.6	85.6	
"	"	"	"	"	"	"	"	12	17.0	16.2	89.5	
"	"	"	"	"	"	"	"	10	16.8	16.0	87.4	
"	"	"	"	"	"	"	"	9	16.3	15.5	87.1	
"	"	"	"	"	"	"	"	10	14.3	13.6	85.6	
"	"	"	"	"	"	"	"	9	16.8	16.0	90.8	
"	"	"	"	"	"	"	"	8	16.8	16.0	88.9	
"	"	"	"	"	"	"	"	6	17.0	16.2	89.0	
"	"	"	"	"	"	"	"	1	7	15.5	14.7	88.0
"	"	"	"	"	"	"	"	10	16.9	16.1	90.3	
"	"	"	"	"	"	"	"	11	16.3	15.5	86.7	
"	"	"	"	"	"	"	"	7	17.0	16.2	87.5	
"	"	"	"	"	"	"	"	12	16.8	16.0	87.5	
"	"	"	"	"	"	"	"	6	13.7	13.0	80.6	
"	"	"	"	"	"	"	"	10	16.4	15.6	85.4	
"	"	"	"	"	"	"	"	11	16.6	15.8	87.8	
"	"	"	"	"	"	"	"	13	16.0	15.2	85.1	
"	"	"	"	"	"	"	"	9	16.6	15.8	87.8	
"	"	"	"	"	"	"	"	8	16.2	15.4	89.5	
"	"	"	"	"	"	"	"	9	14.2	13.5	87.1	
"	"	"	"	"	"	"	"	8	14.9	14.2	84.2	
"	"	"	"	"	"	"	"	13	15.8	15.0	85.9	
"	"	"	"	"	"	"	"	1	8	15.8	15.0	85.9
"	"	"	"	"	"	"	"	1	1	14.7	14.0	85.4
"	"	"	"	"	"	"	"	13	16.4	15.6	87.2	
"	"	"	"	"	"	"	"	9	15.6	14.8	86.2	
"	"	"	"	"	"	"	"	9	15.2	14.4	87.9	
"	"	"	"	"	"	"	"	12	16.9	16.1	93.3	
"	"	"	"	"	"	"	"	9	17.1	16.2	88.5	
"	"	"	"	"	"	"	"	1	6	17.3	16.4	86.9
P. Gimble, Waverly	"	May 1	Oct. 7	Crk bottom	8 in.	16 tons	Potatoes	1	10	15.0	14.3	81.1
"	"	"	"	"	"	"	"	1	5	14.5	13.8	81.5
"	"	"	"	"	"	"	"	1	5	14.5	13.8	81.5

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONTINUED.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.....	Date of harvesting.....	Character of soil.....	Depth of plowing.....	Estimated yield per acre.....	Crop grown on same ground the preceding year.....	Weight of beet..... lbs. oz.	Sugar in juice..	Sugar in beet...	Purity
W. W. Lilly, Menlo.....	Vilmorin Ameliorée..	Apr. 10	Nov. 2	Sandy.....	8 in.	6½ tons	Carrots.....	12	15.8	15.0	83.6
E. W. Lilly, ".....	" ".....	Apr. 24	Nov. 5	".....	6 in.	10½ tons	Nothing.....	1 7	15.2	14.4	85.9
" ".....	" ".....	" ".....	" ".....	".....	".....	13½ tons	".....	1 4	16.5	15.7	85.9
" ".....	Le Maire.....	" ".....	" ".....	".....	".....	13½ tons	".....	1 2	16.3	15.5	89.5
" ".....	Klein Wanzlebener..	" ".....	" ".....	".....	".....	18½ tons	".....	1 5	16.6	15.8	89.2
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	1 3	17.8	16.9	95.2
B. F. Tatten, Steptoe.....	Le Maire.....	" ".....	" ".....	".....	".....	".....	".....	1 1	17.6	16.7	94.6
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	2 3	13.9	13.2	74.7
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	2 14	14.4	13.7	77.8
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	1 14	16.2	15.4	88.5
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	2 5	14.9	14.2	84.6
" ".....	Vilmorin Ameliorée..	" ".....	" ".....	".....	".....	".....	".....	2 14	15.0	14.3	88.2
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	3 8	14.5	13.8	85.3
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	2 14	14.8	14.1	86.0
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	3 8	15.2	14.4	86.4
" ".....	Klein Wanzlebener..	" ".....	" ".....	".....	".....	".....	".....	2 2	16.8	16.0	87.4
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	3 12	12.0	11.4	70.6
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	1 7	13.6	12.9	78.2
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	3 3	13.3	12.6	76.9
H. Carlton, Orting.....	Vilmorin Ameliorée..	" ".....	" ".....	".....	".....	".....	".....	1	13.6	12.9	81.4
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	1 14	15.2	14.4	83.5
" ".....	Le Maire.....	" ".....	" ".....	".....	".....	".....	".....	1	14.3	13.6	80.8
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	1 12	14.0	13.3	83.8
" ".....	Klein Wanzlebener..	" ".....	" ".....	".....	".....	".....	".....	1 14	14.5	13.8	84.3
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	1 12	16.0	15.2	87.4
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	1 2	15.0	14.3	88.9
Martin George, Orting.....	" ".....	May 1	Oct. 29	Sandy loam.....	10 in.	15 tons	Potatoes.....	1 7	15.0	14.3	87.7
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	1 1	16.0	15.2	88.9
" ".....	Le Maire.....	" ".....	" ".....	".....	".....	".....	".....	1 7	15.0	14.3	87.7
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	3 8	15.6	14.8	86.4
" ".....	Vilmorin Ameliorée..	" ".....	" ".....	".....	".....	".....	".....	1 8	15.6	14.8	86.7
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	2 2	15.7	14.9	90.7
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	2 5	15.8	15.0	95.2
A. T. Jones, ".....	Klein Wanzlebener..	May 10	Oct. 26	".....	".....	16 tons	Oats.....	1 4	15.5	14.7	86.5
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	1 1	15.8	15.0	86.5
" ".....	Lane's Imperial.....	" ".....	" ".....	".....	".....	".....	".....	1 7	13.9	13.2	84.2
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	1 14	11.1	10.5	80.4
" ".....	" ".....	" ".....	" ".....	".....	".....	".....	".....	2	9.4	8.9	75.8
E. W. White, St. John.....	Klein Wanzlebener..	" ".....	" ".....	".....	".....	".....	".....	2 9	14.4	13.7	84.7

E. W. White, St. John.	Klein Wanzlebener.	May 7	Black loam.	10 in.	Wheat.	12	15.9	15.1	85.0
J. A. Ledbetter, Pine City.	Knauer's Imperial.	"	"	"	"	2	14.8	14.1	81.3
Unknown,	Unknown.	"	"	"	"	1	18.0	16.9	85.0
"	"	"	"	"	"	2	17.3	16.4	87.4
"	"	"	"	"	"	1	16.4	15.6	87.8
J. J. Crow, Kent.	Knauer's Imperial.	"	"	"	"	1	16.7	15.9	84.9
"	"	"	"	"	"	8	13.1	12.4	86.5
"	"	"	"	"	"	1	15.3	14.5	81.4
"	"	"	"	"	"	1	15.3	12.8	86.4
C. E. Carpenter, Kent.	Klein Wanzlebener.	"	"	"	"	1	10.2	11.4	82.8
"	Knauer's Imperial.	June 6	"	"	"	1	12.1	11.5	78.9
"	Klein Wanzlebener.	"	"	"	"	1	12.1	10.4	78.6
"	"	"	"	"	"	1	12.1	10.4	74.2
Grant Palmer, Tekoa.	Knauer's Imperial.	Nov. 1	Sandy loam.	10 in.	Onions.	1	10.0	9.5	90.9
"	"	"	"	"	"	3	10.0	9.5	90.9
"	"	"	"	"	"	1	11.5	10.9	74.7
W. C. Schuld,	Knauer's Imperial.	Nov. 5	"	4 in.	"	8	14.2	13.5	80.2
H. H. Noble,	"	"	"	"	"	11	13.0	12.4	81.0
"	Mette.	May 5	"	"	"	10	14.3	13.8	76.5
"	"	May 15	"	"	"	11	14.6	13.9	78.9
O. D. Moody,	Klein Wanzlebener.	"	"	"	"	13	16.3	15.5	90.0
H. H. Warner,	Knauer's Imperial.	"	"	"	"	1	17.4	16.5	91.1
T. Gibson, Kent.	Klein Wanzlebener.	May 8	Black loam.	12 in.	Potatoes.	1	15.3	14.5	90.0
"	"	"	"	"	"	1	12.1	11.5	74.3
"	Knauer's Imperial.	"	"	"	"	4	13.6	12.9	75.6
"	"	"	"	"	"	9	12.0	11.4	68.6
Jesse King,	"	"	"	"	"	12	13.2	12.5	76.3
"	"	"	"	"	"	11	16.5	15.7	84.6
"	Klein Wanzlebener.	"	"	"	"	12	15.3	14.5	81.4
G. H. Waid,	"	"	"	"	"	10	15.2	14.4	82.6
"	"	"	"	"	"	8	14.6	13.9	84.9
E. E. Alexander, Spokane.	Mette.	May 22	Sandy loam.	8 in.	Grass.	1	14.7	14.0	84.0
"	Vilmorin Ameloree.	Apr. 19	"	14 in.	Potatoes.	1	16.9	16.1	88.0
"	"	"	"	"	"	1	13.5	13.8	81.0
"	Klein Wanzlebener.	"	"	"	"	5	18.9	18.0	93.5
"	"	"	"	"	"	1	19.8	18.8	92.5
"	Le Maire.	"	"	"	"	6	19.7	18.7	97.0
"	"	"	"	"	"	1	15.7	14.9	82.6
Elias Cornell, Stamokawa.	Klein Wanzlebener.	May 15	"	10 in.	"	8	19.8	18.8	94.1
"	"	"	"	"	"	7	12.4	11.8	74.7
J. M. Lott,	Knauer's Imperial.	"	"	"	"	2	13.9	13.2	77.7
"	"	"	"	"	"	2	13.9	13.2	77.7
Geo. W. Elliott, Ellensburg.	Klein Wanzlebener.	May 25	"	"	Beets.	1	14.8	14.1	86.1
W. J. McCausland,	Vilmorin Improved.	"	"	"	"	1	15.2	14.4	86.9
"	"	"	"	"	"	8	14.0	13.3	84.3
"	Klein Wanzlebener.	"	"	"	"	11	9.5	9.0	76.6
"	"	"	"	"	"	9	9.6	9.1	79.3
John Burglin,	Unknown	"	"	"	"	6	14.1	14.1	86.1
"	"	"	"	"	"	9	17.6	16.7	89.3
"	"	"	"	"	"	11	16.1	15.3	82.6

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON — CONTINUED.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.....	Date of harvesting	Character of soil	Depth of plowing	Estimated yield per acre	Crop grown on same ground the preceding year	Weight of beet..... lbs. oz.	Sugar in juice..	Sugar in beet...	Purity.....
John Burglin, Ellensburg	Unknown	May 25	Oct. 29	Sandy	8 in.		Potatoes	8	15.5	14.7	75.6
" " "	"	"	"	"	"		"	6	15.4	14.6	79.8
Horton Crandall,	Vilmorin Ameliorée.	"	"	"	"		"	5	16.2	15.4	83.1
" " "	"	"	"	"	"		"	9	14.8	14.1	81.8
" " "	Klein Wanzlebener	"	"	"	"		"	10	18.7	17.8	92.5
" " "	"	"	"	"	"		"	6	18.6	17.7	92.1
" " "	Le Maire	"	"	"	"		"	3	17.4	16.5	90.2
" " "	"	"	"	"	"		"	1	10	19.2	91.4
" " "	"	"	"	"	"		"	7	18.1	17.2	88.7
J. L. Brown,	Klein Wanzlebener	May 15	"	Sandy loam	"		"	8	14.5	13.8	91.2
" " "	"	"	"	"	"		"	6	14.9	14.2	88.1
" " "	Vilmorin Richet.	"	"	"	"		"	6	13.8	13.1	88.5
" " "	"	"	"	"	"		"	11	15.9	15.1	86.4
Unknown	Unknown	"	"	"	"		"	5	15.5	14.7	83.8
" " "	"	"	"	"	"		"	1	14.3	13.6	84.1
" " "	Klein Wanzlebener	"	"	"	"		"	8	17.5	16.6	94.5
" " "	"	"	"	"	"		"	10	16.4	15.6	84.1
" " "	"	"	"	"	"		"	1	9	14.0	76.1
" " "	"	"	"	"	"		"	11	16.2	15.4	84.8
" " "	"	"	"	"	"		"	7	16.1	15.3	80.5
" " "	"	"	"	"	"		"	5	16.7	15.9	83.5
" " "	Knauer's Imperial	"	"	"	"		"	6	16.5	15.7	86.4
" " "	"	"	"	"	"		"	5	16.7	14.9	82.2
S. M. Prater,	Mette	May 20	Oct. 29	Sandy loam	7 in.		Wheat	6	15.7	14.9	90.7
" " "	"	"	"	"	"		"	5	16.7	15.9	90.7
" " "	Klein Wanzlebener	"	"	"	"		"	8	15.2	14.4	85.9
" " "	"	"	"	"	"		"	7	15.6	14.8	83.4
" " "	"	"	"	"	"		"	10	16.6	15.8	92.7
" " "	"	"	"	"	"		"	8	15.5	14.7	91.1
Mrs. Montgomery, Ellensburg.	Vilmorin Ameliorée.	June 17	Oct. 31	Sandy loam	4 in.		Potatoes	1	15.5	14.8	94.0
" " "	"	May 15	Oct. 29	"	"		"	9	15.6	14.8	90.6
" " "	Le Maire	"	"	"	"		"	10	16.4	15.6	94.0
" " "	Knauer's Imperial	May 18	"	"	7 in.		Cabbages	10	11.2	10.6	66.3
" " "	"	"	"	"	"		"	1	10	11.8	79.7
" " "	Vilmorin Improved	June 1	"	"	6 in.		Potatoes	10	10.4	9.9	74.8
" " "	"	"	"	"	"		"	6	10.5	10.0	79.0
" " "	"	"	"	"	"		"	12.5	11.9	11.9	84.0
M. Rollinger,	Klein Wanzlebener	May 1	Oct. 30	"	8 in.		"	1	11.1	10.5	82.2
" " "	"	"	"	"	"		"	11			

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ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONTINUED.

<i>Name of grower and postoffice address.</i>	<i>Variety of beets grown.</i>	<i>Date of planting.....</i>	<i>Date of harvesting</i>	<i>Character of soil.....</i>	<i>Depth of plowing.....</i>	<i>Estimated yield per acre</i>	<i>Crop grown on same ground the preceding year</i>	<i>Weight of beet.....</i>	<i>Sugar in juice..</i>	<i>Sugar in beet...</i>	<i>Purity.....</i>
								lbs. oz.			
T. Heitstumann, Uniontown	Le Maire.....	.....	.....	.....	.....	.....	.....	1 15	14.8	14.1	79.6
" " "	" " ".....	.....	.....	.....	.....	.....	.....	2 1	15.2	14.4	82.2
" " "	Vilmorin Ameliorée.....	.....	.....	.....	.....	.....	.....	2 2	16.7	15.9	88.8
Jos. Scherer, " "	Klein Wanslebenér.....	.....	.....	.....	.....	.....	.....	1 15	17.0	16.2	88.1
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 1	16.9	16.1	87.5
" " "	Mette.....	.....	.....	.....	.....	.....	.....	1 3	16.2	15.4	84.8
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 1	16.3	15.5	90.0
" " "	Vilmorin Ameliorée.....	.....	.....	.....	.....	.....	.....	14	16.9	16.1	87.5
" " "	" " ".....	.....	.....	.....	.....	.....	.....	14	15.6	14.8	86.7
F. E. Deeringhoff, " "	Knauer's Imperial.....	.....	.....	.....	.....	.....	.....	1 2	15.8	15.0	86.8
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 1	14	14.8	81.7
" " "	Mette.....	.....	.....	.....	.....	.....	.....	1 10	15.6	14.8	83.9
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 1	15.6	14.8	83.9
" " "	Le Maire.....	.....	.....	.....	.....	.....	.....	2 3	15.8	15.3	82.2
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 3	17.0	16.2	85.9
" " "	Klein Wanzlebenér.....	.....	.....	.....	.....	.....	.....	1 13	16.2	15.4	82.7
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 10	15.5	14.7	82.9
" " "	Mette.....	.....	.....	.....	.....	.....	.....	1 15	15.1	14.3	82.1
J. D. Driessel, " "	" " ".....	.....	.....	.....	.....	.....	.....	1 1	16.0	15.2	82.0
" " "	Le Maire.....	.....	.....	.....	.....	.....	.....	14	16.0	15.2	82.0
John Luy, " "	" " ".....	.....	.....	.....	.....	.....	.....	13	15.9	15.1	82.8
" " "	Mette.....	.....	.....	.....	.....	.....	.....	8	12.1	11.5	82.3
" " "	" " ".....	.....	.....	.....	.....	.....	.....	8	14.5	13.8	85.3
" " "	Klein Wanzlebenér.....	.....	.....	.....	.....	.....	.....	10	15.0	14.3	86.2
Will " "	" " ".....	.....	.....	.....	.....	.....	.....	13	16.8	16.0	91.3
" " "	Vilmorin Ameliorée.....	.....	.....	.....	.....	.....	.....	11	15.8	15.0	85.9
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 1	15.4	14.6	86.0
S. Dahm, " "	Mette.....	.....	.....	.....	.....	.....	.....	1 1	15.3	14.5	84.5
" " "	" " ".....	.....	.....	.....	.....	.....	.....	4	15.2	14.4	81.7
L. Tanfen, " "	Vilmorin Ameliorée.....	.....	.....	.....	.....	.....	.....	1 15	15.4	14.6	84.2
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 8	15.0	12.4	76.5
" " "	Le Maire.....	.....	.....	.....	.....	.....	.....	1 15	15.0	14.3	82.9
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 11	13.8	13.1	83.1
" " "	Klein Wanzlebenér.....	.....	.....	.....	.....	.....	.....	1 1	14.5	13.9	82.5
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 15	16.0	15.2	85.1
" " "	" " ".....	.....	.....	.....	.....	.....	.....	1 1	14.6	13.9	78.9

[illegible]

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON — CONTINUED.

<i>Name of grower and postoffice address.</i>	<i>Variety of beets grown.</i>	<i>Date of plant- ing.....</i>	<i>Date of har- vesting</i>	<i>Character of soil</i>	<i>Depth of plowing.....</i>	<i>Estimated yield per acre</i>	<i>Crop grown on same ground the preceding year.....</i>	<i>Weight of beet.....</i>	<i>Sugar in juice..</i>	<i>Sugar in beet ...</i>	<i>Purity.....</i>	
								lbs. oz.				
J. W. Hereford, Colfax, "	Vilmorin Ameliorée..	" "	" "	" "	" "	" "	" "	3 2	15.1	14.3	80.3	
	" "	" "	" "	" "	" "	" "	" "	3 6	15.1	14.3	81.2	
	Klein Wanzlebener..	" "	" "	" "	" "	" "	" "	3 3	15.3	14.5	82.3	
	" "	" "	" "	" "	" "	" "	" "	2 6	13.4	12.7	75.7	
	" "	" "	" "	" "	" "	" "	" "	1 4	14.9	14.2	84.2	
	" "	" "	" "	" "	" "	" "	" "	1 4	13.5	12.8	79.4	
	" "	" "	" "	" "	" "	" "	" "	1 9	15.3	14.5	82.3	
	" "	" "	" "	" "	" "	" "	" "	1 11	16.0	15.2	75.1	
	Le Maire.....	May 20 " "	Nov. 6 " "	" "	" "	12 in.	Nothing	1	16.8	16.0	81.6	
	" "	" "	" "	" "	" "	" "	" "	9	16.3	15.5	85.8	
Julius Creuzer, " " " " " " " " " " " " " " " " " "	Klein Wanzlebener..	" "	" "	" "	" "	" "	" "	9	16.0	15.2	87.4	
	" "	" "	" "	" "	" "	" "	" "	7	17.5	16.6	82.1	
	" "	" "	" "	" "	" "	" "	" "	11	17.9	17.0	89.5	
	Vilmorin Ameliorée..	" "	" "	" "	" "	" "	" "	2	15.8	15.0	89.3	
	" "	" "	" "	" "	" "	" "	" "	15	14.5	13.8	78.0	
	" "	" "	" "	" "	" "	" "	" "	1 14	14.0	13.3	78.7	
	" "	" "	" "	" "	" "	" "	" "	1 2	15.8	15.0	85.9	
	" "	" "	" "	" "	" "	" "	" "	1 2	15.9	15.1	86.4	
	" "	" "	" "	" "	" "	" "	" "	14	13.9	13.2	78.6	
	" "	" "	" "	" "	" "	" "	" "	14	14.6	13.9	81.6	
M. L. Helzel, " " " " " " " " " " " " " " " " " "	Mette.....	" "	" "	" "	" "	" "	" "	1 5	15.5	14.7	84.7	
	" "	" "	" "	" "	" "	" "	" "	1 14	15.1	14.7	84.7	
	" "	" "	" "	" "	" "	" "	" "	1 3	13.4	12.7	84.3	
	" "	" "	" "	" "	" "	" "	" "	1 6	14.1	13.4	80.0	
	" "	" "	" "	" "	" "	" "	" "	1 3	14.2	13.5	81.6	
	" "	" "	" "	" "	" "	" "	" "	1 11	15.3	14.5	86.4	
	" "	" "	" "	" "	" "	" "	" "	1 14	14.3	13.6	84.1	
	" "	" "	" "	" "	" "	" "	" "	2 3	13.7	13.0	80.6	
	" "	" "	" "	" "	" "	" "	" "	1 10	14.4	13.7	85.2	
	" "	" "	" "	" "	" "	" "	" "	1 9	14.5	13.8	82.8	
Geo. Ruedy, " " " " " " " " " " " " " " " " " "	" "	" "	" "	" "	" "	" "	" "	1 11	12.3	11.7	75.5	
	" "	" "	" "	" "	" "	" "	" "	2	4	15.2	14.4	83.5
	" "	" "	" "	" "	" "	" "	" "	1 4	15.9	15.1	86.0	
	" "	" "	" "	" "	" "	" "	" "	1 2	15.0	14.3	86.2	
	" "	" "	" "	" "	" "	" "	" "	1 1	15.0	14.3	84.7	
	" "	" "	" "	" "	" "	" "	" "	1 5	15.3	14.5	80.5	
	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "	
	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "	
	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "	
	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "	" "	

Geo. Ruedy, Colfax.....	Mette.....						1	4	16.2	15.4	83.5
" " " "	" " " "						1	9	16.9	16.1	85.9
" " " "	" " " "						1	7	16.1	15.3	83.4
S. J. Chadwick, Colfax ..	Unknown.....						1	4	14.0	13.3	82.3
" " " "	" " " "						1	13	16.3	15.5	87.1
" " " "	" " " "							13	15.0	14.3	86.7
" " " "	" " " "						15	15.8	15.0	91.9	
" " " "	" " " "						15	11.6	11.0	83.1	
E. W. White, St. John....	Klein Wanzelebner..						1		13.9	13.2	89.6
" " " "	" " " "						1	1	14.1	13.4	83.4
" " " "	" " " "						15	15	16.8	16.0	89.4
Wm. Beck, Kelso.....	" " " "						14	14	15.8	15.0	87.3
J. Swinehart, Nooksack..	Vilmorin Ameloree..	Apr. 26	Oct. 30.	Hill land.....	8 in.		2	8	15.5	14.7	86.5
" " " "	Klein Wanzelebner..	May 25	Nov. 3	Sandy loam.....	" "		2	9	16.4	15.6	89.1
" " " "	" " " "	May 10	" "	" "	7 in.		2	3	13.0	12.4	78.3
J. W. Sefton, " " " "	" " " "	" "	" "	" "	" "		1	14	15.0	14.3	87.7
Fred Brown, Ilwaco.....	Vilmorin Ameloree..						1	12	16.4	16.6	90.1
" " " "	" " " "						8	15.1	14.3	86.3	
L. Mooney, Montesano..	Vilmorin Improved..	Apr. 19		Sandy loam.....	8 in.		5	2	5.5	5.2	51.9
J. H. Beardslee, " " "	Klein Wanzelebner..	Apr. 12	Nov. 1	" "	6 in.		5	3	5.4	5.1	60.0
" " " "	" " " "	" "	" "		" "		1	15	13.9	13.2	85.3
" " " "	Vilmorin Ameloree..	" "	" "		" "			11	15.1	14.3	89.3
" " " "	" " " "	" "	" "		" "		12	16.8	16.0	92.3	
" " " "	Le Maire.....	" "	" "		" "		14	13.9	13.2	92.6	
Elias Glenn, " " "	Mette.....	May 16	Nov. 2	Sandy loam.....	8 in.		3	8	12.2	11.6	81.3
" " " "	" " " "	" "	" "		" "		2	12	14.2	13.5	85.6
" " " "	French.....						2	7	8.3	7.9	68.6
Isaac Belknap, Ilwaco...	Klein Wanzelebner..	May 13	Nov. 5	Tide land.....	7 in.		1	7	8.9	8.5	70.6
" " " "	" " " "	" "	" "	" "	" "		10	15.8	15.0	86.3	
" " " "	Le Maire.....	" "	" "	" "	" "		12	13.6	12.9	80.0	
" " " "	" " " "	" "	" "	" "	" "		10	13.7	13.0	78.3	
" " " "	Vilmorin Ameloree..	" "	" "	" "	" "		14	15.5	14.7	89.0	
" " " "	" " " "	" "	" "	" "	" "		12	16.8	16.0	90.8	
Fred. Brown, " " "	Le Maire.....						10	14.7	14.0	85.4	
" " " "	" " " "						1	3	14.4	13.7	86.2
" " " "	Klein Wanzelebner..						13	14.5	13.8	88.4	
" " " "	" " " "						12	17.0	16.2	89.9	
H. B. Hedges, " " "	Le Maire.....	June 16	Nov. 5	Tide land.....	7 in.		12	14.2	13.5	83.5	
" " " "	" " " "	" "	" "	" "	" "		4	14.0	13.3	84.3	
" " " "	Vilmorin Ameloree..	" "	" "	" "	" "		12	14.9	14.2	85.2	
" " " "	" " " "	" "	" "	" "	" "		11	15.7	14.9	85.3	
" " " "	Klein Wanzelebner..	" "	" "	" "	" "		1	7	14.6	13.9	85.7
" " " "	" " " "	" "	" "	" "	" "		1	10	14.3	13.6	84.1

J. S. Wallace, La Conner.....	Mette.....	May 17.....	Nov. 3.....	Marsh land.....	8 in.....	.....	Beets.....	1.....	7.....	15.6.....	14.8.....	90.7.....
".....	".....	".....	".....	".....	".....	".....	".....	".....	".....	".....	".....	91.1.....
A. G. Tillinghast, ".....	Le Maire.....	May 15.....	".....	Clay loam.....	6 in.....	26 tons.....	Potatoes.....	1.....	4.....	16.0.....	15.2.....	90.9.....
".....	".....	".....	".....	".....	".....	".....	".....	1.....	14.....	13.9.....	13.2.....	88.5.....
".....	".....	".....	".....	".....	".....	".....	".....	1.....	6.....	13.0.....	12.4.....	88.9.....
Chas. Moore, ".....	Klein Wanzlebener.....	".....	".....	".....	".....	".....	".....	1.....	7.....	13.5.....	13.8.....	83.5.....
".....	Vilmorin Ameliorée.....	May 10.....	".....	Beaver marsh.....	".....	".....	".....	1.....	15.....	12.6.....	12.0.....	80.8.....
".....	".....	".....	".....	".....	".....	".....	".....	2.....	3.....	15.5.....	14.7.....	98.5.....
".....	".....	".....	".....	".....	".....	".....	".....	2.....	11.....	14.0.....	13.8.....	95.3.....
Unknown.....	Unknown.....	".....	".....	".....	".....	".....	".....	1.....	9.....	12.9.....	12.3.....	80.6.....
".....	".....	".....	".....	".....	".....	".....	".....	1.....	9.....	17.4.....	16.5.....	92.5.....
Edmund Croft, Markham.....	Klein Wanzlebener.....	May 25.....	Nov. 12.....	Tide land.....	6 in.....	5 tons.....	Nothing.....	1.....	1.....	14.6.....	13.9.....	85.4.....
".....	".....	".....	".....	".....	".....	".....	".....	1.....	4.....	14.7.....	14.0.....	80.8.....
".....	".....	".....	".....	".....	".....	".....	".....	1.....	10.....	15.5.....	14.7.....	90.1.....
C. C. McDonald, Blaine.....	".....	".....	".....	".....	".....	".....	".....	1.....	9.....	14.9.....	14.2.....	87.6.....
".....	".....	".....	".....	".....	".....	".....	".....	1.....	10.....	16.1.....	15.3.....	96.4.....
".....	".....	".....	".....	".....	".....	".....	".....	2.....	2.....	16.0.....	15.2.....	91.4.....
".....	".....	".....	".....	".....	".....	".....	".....	2.....	2.....	15.0.....	14.3.....	93.2.....
".....	".....	".....	".....	".....	".....	".....	".....	1.....	12.....	15.9.....	15.1.....	92.4.....
".....	".....	".....	".....	".....	".....	".....	".....	5.....	6.....	11.8.....	11.2.....	81.4.....
J. E. Hart, Cedarville.....	Vilmorin Ameliorée.....	May 25.....	Nov. 3.....	Clay loam.....	8 in.....	4 tons.....	Corn.....	2.....	11.....	14.8.....	14.1.....	89.7.....
".....	".....	".....	".....	".....	".....	".....	".....	3.....	14.....	10.5.....	10.0.....	78.9.....
".....	".....	".....	".....	".....	".....	".....	".....	3.....	11.....	12.1.....	11.5.....	85.0.....
".....	".....	".....	".....	".....	".....	".....	".....	3.....	11.....	13.2.....	12.5.....	84.7.....
".....	".....	".....	".....	".....	".....	".....	".....	3.....	3.....	13.0.....	12.4.....	84.5.....
".....	".....	".....	".....	".....	".....	".....	".....	1.....	2.....	9.8.....	9.3.....	80.7.....
".....	".....	".....	".....	".....	".....	".....	".....	1.....	2.....	14.0.....	13.3.....	85.4.....
Unknown, Dungeness.....	Vilmorin Improved.....	".....	".....	".....	".....	".....	".....	4.....	2.....	12.0.....	11.4.....	87.0.....
".....	".....	".....	".....	".....	".....	".....	".....	3.....	10.....	8.8.....	8.4.....	82.2.....
".....	".....	".....	".....	".....	".....	".....	".....	3.....	6.....	7.5.....	7.1.....	77.3.....
".....	".....	".....	".....	".....	".....	".....	".....	3.....	8.....	11.8.....	11.2.....	85.5.....
".....	".....	".....	".....	".....	".....	".....	".....	4.....	2.....	9.6.....	9.1.....	82.8.....
".....	".....	".....	".....	".....	".....	".....	".....	6.....	2.....	8.2.....	7.8.....	80.4.....
".....	".....	".....	".....	".....	".....	".....	".....	12.....	12.....	7.8.....	7.4.....	78.0.....
".....	".....	".....	".....	".....	".....	".....	".....	4.....	7.....	9.6.....	9.1.....	84.2.....
".....	".....	".....	".....	".....	".....	".....	".....	5.....	3.....	6.3.....	6.0.....	78.0.....
".....	".....	".....	".....	".....	".....	".....	".....	5.....	1.....	8.6.....	8.2.....	70.9.....
".....	".....	".....	".....	".....	".....	".....	".....	2.....	14.....	9.8.....	9.3.....	81.0.....
".....	".....	".....	".....	".....	".....	".....	".....	4.....	6.....	10.5.....	10.0.....	80.1.....
".....	".....	".....	".....	".....	".....	".....	".....	3.....	6.....	9.5.....	9.0.....	79.9.....
".....	".....	".....	".....	".....	".....	".....	".....	9.....	6.....	6.4.....	6.1.....	74.4.....
".....	".....	".....	".....	".....	".....	".....	".....	4.....	3.....	8.0.....	7.6.....	82.5.....
".....	".....	".....	".....	".....	".....	".....	".....	5.....	15.....	10.0.....	9.5.....	80.6.....
".....	".....	".....	".....	".....	".....	".....	".....	5.....	12.....	13.5.....	12.8.....	79.4.....
".....	".....	".....	".....	".....	".....	".....	".....	3.....	2.....	15.3.....	14.5.....	86.4.....
".....	".....	".....	".....	".....	".....	".....	".....	2.....	11.....	14.4.....	13.7.....	82.3.....
".....	".....	".....	".....	".....	".....	".....	".....	3.....	12.....	11.8.....	11.2.....	80.3.....

ANALYSES OF SUGAR BEETS PRODUCED IN WASHINGTON—CONCLUDED.

Name of grower and postoffice address.	Variety of beets grown.	Date of planting.....	Date of harvesting.....	Character of soil.....	Depth of plowing.....	Estimated yield per acre.....	Crop grown on same ground the preceding year.....	Weight of beet..... lbs. oz.	Sugar in juice..	Sugar in beet....	Purity.....
Unknown, Dungeness.	Klein Wanzlebener..	"	"	"	"	"	"	3 84.8	14.0	13.3	84.8
W. J. Windus, Pullman.	"	"	"	"	"	"	"	9 95.3	18.4	17.5	95.3
"	"	"	"	"	"	"	"	9 89.4	18.4	17.5	89.4
R. A. Farr,	"	"	"	"	"	"	"	11 92.2	18.9	18.0	92.2
"	"	"	"	"	"	"	"	1 89.0	15.0	14.3	90.4
"	"	"	"	"	"	"	"	1 92.8	12.8	12.2	92.8
"	"	"	"	"	"	"	"	2 6 12.5	11.9	11.9	92.5
J. F. Gordon, Covello.	Garden Beet.....	"	"	"	"	"	"	1 8 6.3	6.0	6.0	70.8
"	Carrot.....	"	"	"	"	"	"	1 1 5 15.0	14.3	14.3	88.2
"	Mette.....	"	"	"	"	"	"	1 8 16.5	15.7	15.7	91.1
"	"	"	"	"	"	"	"	1 15.2	14.4	14.4	91.0
"	"	"	"	"	"	"	"	1 11 16.2	15.4	15.4	89.5
B. G. Smith, Quilcene.	Vilmorin Ameloree.	"	"	Sandy loam.	6 in.	"	Potatoes	2 13 37.7	13.0	13.0	90.7
"	"	"	"	"	"	"	"	2 3 11.6	11.0	11.0	90.6
"	Klein Wanzlebener.	"	"	"	"	"	"	2 9 12.2	11.6	11.6	89.1
"	Le Maire.....	"	"	"	"	"	"	1 11 15.3	14.5	14.5	86.9
"	"	"	"	"	"	"	"	1 6 13.8	13.1	13.1	86.8
"	"	"	"	"	"	"	"	1 11 15.0	14.3	14.3	89.3
M. F. Hamilton,	Knauer's Imperial.	"	"	"	"	"	"	2 2 13.5	12.9	12.9	90.6
"	"	"	"	"	"	"	"	1 10 14.1	13.4	13.4	85.5
P. Spencer,	Klein Wanzlebener.	"	"	"	"	"	"	1 4 14.8	14.1	14.1	88.1
"	"	"	"	"	"	"	"	1 7 16.7	15.9	15.9	91.7
"	Vilmorin Improved.	"	"	"	"	"	"	2 8 14.0	13.3	13.3	83.3
"	"	"	"	"	"	"	"	2 7 10.3	9.8	9.8	83.8
Unknown.....	Unknown.....	"	"	"	"	"	"	3 1 14.8	14.1	14.1	82.7
James McFarland, Norman.	Mette.....	May 18	Nov. 12	Sandy	8 in.	10 tons	Peas	2 1 12.3	11.7	11.7	82.6
Andrew Estby,	"	May 20	"	"	"	"	"	3 5 11.4	10.8	10.8	80.3
"	"	"	"	"	"	"	"	2 8 10.5	10.0	10.0	80.7
T. W. Calhoun, Coupeville.	Klein Wanzlebener.	Apr. 10	Nov. 18	Black loam.	"	20 tons	Cabbage	3 9 12.9	12.3	12.3	84.3
"	"	"	"	"	"	"	"	1 15 15.1	14.3	14.3	87.8
"	Vilmorin Ameloree.	"	"	"	"	"	"	2 12 14.8	14.1	14.1	88.6
"	"	"	"	"	"	"	"	3 5 14.4	13.7	13.7	87.3
"	Le Maire.....	"	"	"	"	"	"	2 14 14.1	13.7	13.7	88.3
"	"	"	"	"	"	"	"	2 12 14.4	13.7	13.7	88.3
"	"	"	"	"	"	"	"	3 10 13.4	12.7	12.7	87.0
"	"	"	"	"	"	"	"	2 4 14.0	14.0	14.0	87.0

F. R. Hamilton, Baker.....	Klein Wanzlebener.....	May 11	Nov. 12	River bott'm.....	8 in.	15 tons	Potatoes.....	3 12	12.5	11.9	84.5
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	2 12	14.0	13.3	88.1
" " " " " "	Le Maire.....	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	3 11	12.0	11.4	76.9
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	2 13	14.0	13.3	84.3
" " " " " "	Vilmorin Amelioree.....	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	5 5	14.5	13.8	88.9
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	3 15	14.0	13.3	85.9
Thos. Adams, Florence.....	Klein Wanzlebener.....	May 26	" " " " " "	Muck.....	" " " " " "	12 tons	Turnips.....	3 12	11.6	11.0	82.9
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	5 9	9.2	8.7	74.2
James Ledvy, " " " " " "	Mette.....	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 6	13.5	12.8	90.6
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	2 13	14.4	13.7	90.6
John Devlin, Colfax.....	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 2	12.0	11.4	87.0
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 2	12.7	12.1	84.2
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 3	13.3	12.6	88.6
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 8	13.2	12.5	89.8
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 11	15.0	14.3	85.2
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 2	15.5	14.7	83.3
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 2	12.2	11.6	86.5
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 1	14.1	13.4	90.3
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 4	14.3	13.6	90.5
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	5 15	14.4	13.7	90.6
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	5 12	13.8	13.1	82.1
J. W. Hereford, " " " " " "	Vilmorin Amelioree.....	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	4 10	14.1	13.4	83.9
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	11.0	10.5	75.9
W. J. Spillman, Pullman.....	Rutabaga.....	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	13.6	12.9	82.4
" " " " " "	Mangel Wurzel.....	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	2 1	12.2	11.6	76.5
Thos. Secrest, Oakesdale.....	German.....	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	2 4	13.5	12.8	90.6
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 12	12.0	11.4	87.0
J. F. Hines, Ocosta.....	Klein Wanzlebener.....	May 3	Nov. 19	Tide land.....	8 in.	15 tons	Nothing.....	1 14	10.5	10.0	78.9
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 12	12.1	11.5	85.0
" " " " " "	Vilmorin Amelioree.....	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 9	13.2	12.5	84.7
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 6	13.0	12.4	84.5
" " " " " "	Le Maire.....	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 11	9.8	9.3	80.7
" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	" " " " " "	1 10	14.0	13.3	85.4

From these tables the following interesting facts are obtained:

Number of samples yielding less than 10 per cent. of sugar.....	52
“ “ “ between 10 and 11 per cent. of sugar.....	38
“ “ “ 11 and 12 “ “	74
“ “ “ 12 and 13 “ “	134
“ “ “ 13 and 14 “ “	239
“ “ “ 14 and 15 “ “	328
“ “ “ 15 and 16 “ “	336
“ “ “ 16 and 17 “ “	246
“ “ “ 17 and 18 “ “	149
“ “ “ 18 and 19 “ “	68
“ “ “ more than 19 per cent. of sugar.....	36
Highest sugar percentage.....	21.9
Lowest “ “	4.7

It is a most gratifying fact that 1,536, or over 90 per cent. of the 1,700 analyses, show a percentage of sugar higher than the 12 per cent. factory requirement. Were the Vilmorin Improved variety to be excluded in this connection, about 95 per cent. of the total number would show more than 12 per cent. of sugar.

The following averages, by towns, include all varieties:

WESTERN WASHINGTON.

Town.	County.	No. analy- ses.....	Av. wt. of beet, ozs.	Av. per cent. sugar.....	Average purity.....	Best single analysis.		Poorest single analysis.	
						Sugar.	Purity.	Sugar.	Purity.
Agate.....	Lewis.....	6	15	13.7	84.5	14.5	85.3	13.0	84.5
Acme.....	Whatcom.....	4	31	9.6	80.3	10.6	81.8	8.2	73.2
Arlington.....	Snohomish.....	2	40	12.8	80.0	12.9	81.6	12.7	78.4
Blaine.....	Whatcom.....	4	42	14.4	89.2	15.9	92.4	11.8	81.4
Baker.....	Skagit.....	6	58	13.5	84.8	14.5	88.9	12.0	76.9
Beach.....	Whatcom.....	2	23	11.2	78.0	11.5	79.9	10.8	76.1
Coupeville.....	Island.....	6	44	14.2	87.7	14.8	88.6	13.4	87.0
Cedarville.....	Chehalis.....	6	42	12.1	83.2	14.0	85.4	9.8	80.7
Cowlitz.....	Lewis.....	8	17	12.6	81.5	15.5	85.6	8.5	74.5
Centralia.....	Lewis.....	3	5	15.3	83.2	15.8	86.3	15.0	82.0
Chehalis.....	Lewis.....	8	22	12.6	78.6	13.3	79.2	11.7	80.7
Dungeness.....	Clallam.....	21	80	10.2	81.0	15.3	86.4	6.3	70.0
Elma.....	Chehalis.....	12	35	12.6	78.9	14.2	84.0	11.5	79.3
Enterprise.....	Whatcom.....	20	16	14.9	85.8	16.7	90.7	12.3	74.1
Fidalgo.....	Skagit.....	7	3	16.4	88.6	18.3	88.4	13.8	85.2
Fern Hill.....	Pierce.....	7	12	14.9	84.5	16.9	87.5	13.0	74.3
Florence.....	Snohomish.....	4	54	12.2	84.6	14.4	90.6	9.2	74.2
Home Valley.....	Skamania.....	1	3	12.4	82.7				
Hartford.....	Snohomish.....	16	18	14.7	87.5	17.0	92.4	11.0	80.9
Ilwaco.....	Pacific.....	22	18	14.4	84.4	17.0	93.4	10.4	74.3
Kent.....	King.....	18	20	13.3	79.0	16.5	84.6	10.0	70.9
Kelso.....	Cowlitz.....	2	36	14.6	83.5	15.5	86.5	13.7	80.6
Kalama.....	Cowlitz.....	6	26	13.1	83.4	13.8	84.7	11.1	78.2
La Conner.....	Skagit.....	14	24	14.5	86.0	17.4	92.5	12.6	80.8
Markham.....	Chehalis.....	4	27	15.6	91.4	16.1	96.4	14.9	87.6
Montesano.....	Chehalis.....	12	35	11.4	77.7	16.8	92.3	5.4	60.0
Menlo.....	Pacific.....	12	17	16.1	88.8	17.8	95.2	13.7	82.5
Marysville.....	Snohomish.....	10	17	13.0	79.6	15.1	92.6	11.1	72.6
Norman.....	Snohomish.....	4	45	12.5	83.3	15.1	87.8	10.5	80.7
Nooksack.....	Whatcom.....	4	34	15.2	86.3	16.4	90.1	13.0	78.3
Napavine.....	Lewis.....	11	26	13.5	81.4	15.8	86.3	11.5	76.7
Newcastle.....	King.....	6	21	11.5	72.0	13.4	78.4	10.0	67.1
Orting.....	Pierce.....	16	26	14.4	85.4	16.0	88.9	9.4	75.8
Quilcene.....	Jefferson.....	12	33	13.7	88.8	16.7	91.7	10.3	83.8
Roche Harbor.....	San Juan.....	2	38	9.9	64.9	10.9	69.0	9.0	60.9

WESTERN WASHINGTON—CONCLUDED.

Town.	County.	No. analy- ses.....	Av. wt. of beet, ozs..	Av. per ct. sugar	Average purity.....	Best single analysis.		Poorest single analysis.	
						Sugar.	Purity.	Sugar.	Purity.
Sedro.....	Skagit.....	8	21	13.3	80.1	14.0	79.1	12.3	78.0
Sultan.....	Shohomish.....	10	34	14.8	91.3	16.5	94.3	12.2	87.1
Skamokawa.....	Wahkiakum ..	4	31	14.1	81.4	15.2	86.9	12.4	74.7
Toledo.....	Lewis.....	41	22	14.0	84.7	17.1	90.0	7.7	74.0
Willapa.....	Pacific.....	2	13	15.7	87.7	17.6	90.2	13.9	85.3
Whatcom.....	Whatcom.....	12	15	11.8	77.9	13.6	79.5	9.0	69.2
Woolley.....	Skagit.....	4	28	13.3	80.0	14.2	85.5	12.5	78.7
Wickersham.....	Whatcom.....	7	12	13.0	81.0	13.7	83.0	12.0	87.0
Wana.....	Snohomish.....	6	41	11.4	77.5	14.7	87.5	7.7	64.1
Wabash.....	King.....	4	12	11.8	82.2	11.9	83.8	11.7	88.6

EASTERN WASHINGTON.

Asotin.....	Asotin.....	23	13	16.7	85.3	21.9	92.7	12.0	77.4
Aurora.....	Whitman.....	6	17	14.3	84.9	16.1	86.1	12.5	87.4
Anatone.....	Asotin.....	8	19	15.3	83.5	18.1	86.2	13.6	80.0
Belmont.....	Whitman.....	5	47	15.2	80.2	16.5	84.2	14.6	77.6
Covello.....	Columbia.....	4	22	15.7	89.9	16.5	91.1	15.0	88.2
Chewelah.....	Stevens.....	2	27	8.3	58.7	10.0	65.3	6.5	52.0
Cheney.....	Spokane.....	8	35	15.4	80.5	17.2	87.0	13.9	74.3
Crescent.....	Lincoln.....	41	15	15.5	83.1	19.4	82.6	10.7	84.9
Colfax.....	Whitman.....	129	22	15.2	84.1	19.8	94.3	11.6	83.1
Colville.....	Stevens.....	11	22	15.8	86.1	19.8	87.2	13.4	81.7
Colton.....	Whitman.....	24	33	14.2	80.5	17.2	86.9	4.7	50.5
Dayton.....	Columbia.....	54	19	16.0	84.1	20.1	93.3	7.0	62.5
Davenport.....	Lincoln.....	10	7	16.9	78.4	19.3	88.9	10.3	51.5
Diamond.....	Whitman.....	9	18	15.8	85.7	20.9	92.0	12.5	69.1
Dixie.....	Walla Walla.....	8	22	14.4	86.1	15.1	91.5	13.5	83.3
Delight.....	Adams.....	2	3	10.6	81.5	11.6	78.9	9.5	84.1
Ellensburg.....	Kittitas.....	98	10	15.9	85.2	20.0	94.7	9.5	76.6
Fletcher.....	Adams.....	6	10	14.0	86.0	15.3	86.4	10.5	84.7
Fairfield.....	Spokane.....	74	13	15.4	85.3	17.6	92.1	10.3	72.0
Farmington.....	Whitman.....	20	53	12.3	78.1	15.0	82.9	5.8	57.4
Fallons.....	Whitman.....	6	14	15.8	89.1	17.4	85.6	13.5	87.1
Garfield.....	Whitman.....	46	17	15.2	85.4	19.8	96.6	10.1	77.7
Guy.....	Whitman.....	25	24	15.3	85.5	17.8	90.3	10.9	72.1
Gould City.....	Garfield.....	2	48	14.3	80.3	14.6	81.1	14.0	79.5
Harvey.....	Stevens.....	8	24	15.7	82.4	17.7	86.3	12.0	71.4
Kettle Falls.....	Stevens.....	8	12	15.6	85.0	17.1	89.1	13.8	76.7
Laraine.....	Lincoln.....	4	10	17.2	92.7	18.5	95.7	15.0	90.9
Latah.....	Spokane.....	20	26	14.5	82.4	17.0	82.5	11.0	77.5
Marshall.....	Spokane.....	2	45	13.2	81.6	14.2	85.0	12.2	78.2
Medical Lake.....	Spokane.....	6	15	14.4	74.3	18.5	78.0	11.2	66.1
Mayview.....	Garfield.....	13	34	14.2	78.5	16.6	84.7	11.9	69.6
Oakesdale.....	Whitman.....	21	38	13.5	80.5	16.6	86.5	9.3	77.5
Pomeroy.....	Garfield.....	32	37	14.8	80.1	17.6	82.2	11.0	66.6
Palouse.....	Whitman.....	23	15	15.6	83.8	18.6	88.6	12.9	81.1
Prescott.....	Walla Walla.....	6	30	15.7	84.3	17.5	89.7	13.7	81.1
Pine City.....	Whitman.....	6	23	16.8	85.5	18.8	87.4	14.8	81.3
Pullman.....	Whitman.....	106	20	15.8	84.4	19.4	89.8	12.3	77.4
Pataha.....	Garfield.....	9	36	13.0	79.0	16.6	86.5	10.8	71.1
Plaza.....	Spokane.....	8	27	16.1	85.5	19.3	91.4	13.2	75.9
Reardon.....	Lincoln.....	18	19	16.4	84.3	17.9	86.9	14.3	71.1
Rockford.....	Spokane.....	8	15	13.7	82.1	15.1	86.8	12.9	83.8
Rosalia.....	Whitman.....	15	16	16.7	89.4	19.6	90.3	14.3	82.2
Riparia.....	Columbia.....	4	14	15.9	85.9	16.3	90.5	13.9	81.3
St. John.....	Whitman.....	5	7	15.4	85.9	16.8	89.4	14.1	83.4
Steptoe.....	Whitman.....	12	43	14.5	82.1	16.8	87.4	12.0	70.6
Sprague.....	Lincoln.....	3	4	14.6	67.6	15.5	75.6	13.0	58.0
Starbuck.....	Columbia.....	6	18	13.8	75.9	17.0	84.6	11.4	70.3
Spokane.....	Spokane.....	32	19	15.5	82.6	19.8	94.1	12.6	76.8
Sunset.....	Whitman.....	4	42	14.2	82.9	16.1	88.4	11.9	78.8
Tekoa.....	Whitman.....	19	20	14.2	82.3	17.4	91.1	11.1	79.9
Uniontown.....	Whitman.....	120	28	15.2	82.7	18.2	89.2	11.2	75.7
Unknown.....		36	18	15.7	85.1	21.5	90.7	8.5	72.7
Waverly.....	Spokane.....	65	18	15.1	84.4	17.8	87.6	9.5	80.5
Welch.....	Spokane.....	12	12	15.1	79.8	18.3	88.4	12.4	71.6
Walla Walla.....	Walla Walla.....	14	66	12.2	74.4	17.5	81.8	7.0	49.6
Yakima City.....	Yakima.....	4	23	13.8	80.1	14.4	82.3	13.0	78.3

Averaging the analyses from each county, results are obtained that form an interesting study. All varieties are also included here:

COUNTY AVERAGES.

<i>Name.</i>	<i>No. of analyses.</i>	<i>Av. weight in ozs.,...</i>	<i>Av. sugar...</i>	<i>Av. purity.</i>
Adams	8	6	12.3	83.7
Asotin	26	16	16.0	84.4
Clallam	21	80	10.2	81.0
Cowlitz	8	31	13.8	83.4
Chehalis	34	35	12.9	82.8
Columbia	68	18	15.3	83.9
Garfield	56	39	14.0	79.4
Island	6	44	14.2	87.7
Jefferson	12	33	13.7	88.8
Kittitas	98	10	15.9	85.2
King	28	18	12.2	77.7
Lincoln	76	11	16.1	81.2
Lewis	77	18	13.6	82.3
Pierce	23	19	14.6	84.9
Pacific	36	16	15.4	86.9
Spokane	235	22	14.8	81.8
Stevens	29	21	13.8	78.5
Snohomish	52	36	13.5	83.4
Skamania	1	3	12.4	82.7
Skagit	33	19	14.3	83.6
San Juan	2	38	9.9	64.9
Whatcom	59	29	12.2	82.9
Wahkiakum	4	31	14.1	81.4
Walla Walla	28	39	14.1	81.6
Whitman	597	25	15.1	83.9
Yakima	4	23	13.8	80.1

It will be seen from this table that only two counties fall below the required 12 per cent. of sugar. In the case of Clallam county nearly all of the 21 samples were of the variety "Vilmorin Improved." Only four counties have an average purity below 80. These averages do not impress one with their real significance unless one keeps in mind the factory requirements, viz., 12 per cent. of sugar and a purity of 80.

Beets were received and analyzed from forty-five towns west and fifty-six east of the Cascade mountains. The following comparison will be of interest when we consider the wide variations of conditions between these two portions of the state:

<i>Locality.</i>	<i>No. of towns.</i>	<i>No. of analyses.</i>	<i>Average wt. of beet.</i>	<i>Av. per cent. of sugar.</i>	<i>Average purity.</i>
Eastern Washington.....	56	1,270	23 oz.	14.9	82.4
Western Washington.....	45	396	26 oz.	13.3	82.8

These averages include all analyses.

Eliminating from them the variety "Vilmorin Improved," the following results are obtained:

<i>Locality.</i>	<i>No. of towns.</i>	<i>No. of analyses.</i>	<i>Average wt. of beet.</i>	<i>Av. per cent. of sugar.</i>	<i>Average purity.</i>
Eastern Washington	56	1,188	21 oz.	15.5	83.8
Western Washington.....	45	360	24 oz.	14.9	83.8

While 1,700 analyses were made, these averages were computed before some of these samples arrived; hence only 1,666 analyses are included in them.

For the entire state, including all varieties, we have the following data: 1,666 analyses; average weight, 25 ounces; average sugar, 14.2 per cent.; average purity, 82.6.

Included in this are 122 analyses of the variety "Vilmorin Improved," which averaged as follows: Weight, 43 ounces; sugar, 11.1 per cent.; purity, 77.0.

Eliminating this variety from the state average (which it is manifestly just to do for reasons already given) we have the following: 1,544 analyses; average weight, 22 ounces; average sugar, 15.2 per cent.; average purity, 83.8.

What do These Results Mean to the State of Washington?

In order to realize to the fullest extent what these results mean to us we must know about the results obtained in other states. We give below some data taken from the bulletins of the different experiment stations:

<i>State.</i>	<i>No. of bulletins.....</i>	<i>Season.....</i>	<i>No. of analyses averaged ...</i>	<i>Average sugar percentage.</i>	<i>Average purity.....</i>
North Dakota.....	5	1891	129	11.4	78.1
Oregon.....	23	1892	65	15.7	75.8
South Dakota	34	1892	160	13.9	77.1
Wisconsin.....	26	1890	93	12.5	80.9
Wyoming.....	17	1893	33	17.1	78.9
Indiana.....	49	1893	49	12.5	76.1
Iowa.....	23	1893	55	11.9	74.0
Kansas.....	36	1892	95	11.0	86.4
Michigan	82	1891	239	13.8	82.3
Minnesota.....	27	1892	182	14.4	83.1
Colorado.....	14	1890	72	11.6	83.8
Washington .....	.....	1894	1,544	15.2	83.8

It will be noticed that only two states, Oregon and Wyoming, have obtained averages approximating to those obtained here last

year; and in both cases the number of samples averaged was less than one hundred.

Beets of the highest degree of perfection result only from the most thorough and intelligent cultivation. The samples analyzed last year were grown under the most unfavorable culture conditions, and selected by men who were, in the main, wholly unacquainted with the characteristics of beets containing a high percentage of saccharine matter. It is, therefore, fair to presume that the average above given is, at least, no higher than would be obtained from beets grown for factory purposes.

These results then simply mean that the State of Washington can produce beets of a character greatly to be desired by factories.

Will the Beet Sugar Industry Be Established in Washington?

That depends. The work just completed demonstrates the superior character of Washington beets. In regard to tonnage yield, we can give no accurate data. It is probable that an average of twenty tons per acre would be a conservative estimate; but this is only an estimate and not based upon accurate measurement of ground, and weight of beets produced. However, those who know the capabilities of our soil have no fear of disappointment from low yield. Another very important point upon which the introduction of this industry will depend is the cost of production. Our farmers must understand from the outset that it will cost time, labor, and money to raise a crop of beets that will yield proper returns. And it is self-evident that they will not undertake to raise beets for a factory until they are convinced that the large outlay of energy and money necessary to raise them will yield proportionately larger returns than a smaller outlay applied to raising some other crop. In other words, the future of beet culture in this state, as elsewhere, depends entirely on the return it yields—the cost of production on the one hand, and the yield per acre and price per ton paid by the factory, on the other. As nearly as can be ascertained from the statistics concerning beet culture in Nebraska, the cost of production averages from \$30 to \$40 per acre, where no fertilizers are used. There is no good reason why it should cost a greater sum to produce an acre of beets in Washington, and some very good reasons why it should cost less. The weed problem is much more easily met in Washington than in older agricultural states. One good hoeing, in this state, will accomplish as much in weed destruction as two hoeings in Nebraska. This is by no

means an insignificant item. Ten dollars is the average of four estimates obtained concerning the actual cost of the labor for hoeing an acre of beets in Nebraska. Those who have observed carefully the agricultural conditions in the two states will sustain the assertion that one-half the labor required to keep weeds down there, will easily accomplish the same object here. Hence, in this point alone, assuming our yield to be twenty tons per acre, the cost of production will be twenty-five cents per ton less here than in Nebraska.

It must not be supposed, however, that the beets are hoed for the sole purpose of killing weeds. A certain amount of labor expended in stirring the soil, to admit free circulation of air to the roots, would be very necessary, even though the weeds were wholly absent. And further, up to certain limits, the yield of saccharine matter in the roots will be largely dependent on the amount of labor directed to this end. But every farmer knows that it is cheaper and easier to simply stir the soil than it is to kill weeds at the same time. The comparatively few weeds we have is then one point in favor of the farmer in beet production.

We do not advocate beet farming alone, but as a factor of diversity. It has been urged that beets exhaust the soil too quickly, and it is very true that a forced culture of beets would, in a comparatively short time, cause a decrease in soil productivity; but this is also true of other crops when they are made the object of forced culture. An intelligent culture of beets, as a crop in rotation, works no more injury to the soil than does wheat, oats, or hops, and in some respects improves it. Dr. Wiley says:

The establishment of sugar beet culture becomes a true lesson in agriculture. Every field properly cultivated in beets becomes an agricultural experiment station. The influence of beet culture is felt upon every other crop. The yield per acre of cereals, root crops, and grasses, is always found higher in a community after the introduction of beet culture.

How much will the farmer receive for his beets? This is, of course, impossible to state. We can simply be guided in our estimations by what the factories now in operation pay per ton. In Nebraska, during 1894, the price paid was \$5 per ton. If 2,000 acres of the crop of 1895 are contracted, the Norfolk factory agrees to pay \$4 per ton straight, or \$3.50 per ton for 12 per cent. beets, and twenty-five cents more per ton for each additional per cent. of sugar in the beets. In Utah, \$5 per ton was paid for last year's crop, but will be much lower for the crop of 1895. At Watsonville, Cali-

fornia, the price will be \$4 per ton, while at Chino, California, \$3.50 will be paid for 12 per cent. beets, and twenty-five cents more per ton for each and every additional per cent. of sugar in the beets.

From these figures we see that the lowest price agreed upon for the crop of 1895 is \$4 per ton where payment is not based upon sugar percentage. Suppose our Washington farmers should raise fifteen tons per acre, which we believe to be a low estimate, the amount received per acre for the beets would be \$60. Count the cost of production \$40 per acre, which is undoubtedly high, and the *net profit* is then \$20 per acre. This would be much more remunerative than fifty bushels per acre of fifty cent wheat.

Our state bounty law provides that one-half cent per pound shall be paid to the farmer for all sugar manufactured from his beets. The beet crop of 1893 in the United States yielded an average of 230.7 pounds of sugar per ton of beets. Fifteen tons per acre, on this basis, would yield 3,460 pounds of sugar, upon which the bounty would be \$17.30. This amount, added to net profit from sale of beets, gives \$37.30 per acre *clear* to the beet grower. It is true, as we have been told, that these calculations are all on paper, but there is no reason why they should not be verified in practical experience.

These, then, are the inducements to the farmer to engage in the sugar beet industry. What inducements can be offered to the manufacturer? Anyone contemplating the erection of a factory will demand (1) beets of a satisfactory quality, and plenty of them; (2) an abundance of good water; (3) plenty of good limestone; (4) cheap fuel. Can we satisfy these demands?

(1) There can be no longer any doubt of our ability to produce satisfactory beets. During the progress of these experiments the statement was circulated in certain sections of the state that while our beets were rich in sugar, their purity was so low that the sugar would not crystallize. This statement is fully disproved by the work now completed. In factory operations, crystallization is prevented by the presence in the beet juice of mineral salts taken from the soil. The extent to which these salts are present is positively indicated by the number expressing purity. That is to say, a beet juice having a purity of 80, has, among its total solids, 20 per cent. of matter not sugar. This 20 per cent. is made up largely of sugars other than sucrose, and mineral salts. Now, when little or no difficulty is experienced in manufacturing sugar from beets of 80

purity, it is absurd to think those having a still higher purity would fail to give as good results.

From the present agricultural conditions prevailing in our state, there is scarcely room for any doubt about the ability of the manufacturer to contract as many acres of beets as he desires. We know that there are a number of places in the state where the farmers are anxious to contract for from 5,000 to 10,000 acres.

(2) The question of a local water supply will, in the very nature of things, preclude the possibility of a sugar factory in some sections of the state. A factory of 350 tons daily capacity will require about two million gallons of water every 24 hours. This amount of water can be easily supplied in many places that can also produce suitable beets.

(3) We have an abundance of unusually pure limestone that is easily accessible. One sample of crystalline limestone from Stevens county, analyzed in our laboratory, was 98 per cent. pure. A factory will use from fifteen to twenty tons daily.

(4) The possibility of cheap fuel will be conditioned somewhat upon the location of the factory. If all other conditions are fully met, the question of fuel supply will be easily adjusted.

If we are to have sugar factories in Washington, we will, in all probability, be obliged to face the question of subsidy to capital, regardless of our opinion concerning the economic policy involved.

What a Sugar Factory Means to a Community.

It is argued by some that inasmuch as a factory is not in operation during the entire year, employs less than 200 men, and uses the product of less than 10,000 acres, that its beneficial effects would be too local to affect districts more remote from it. Those who have seen these factories in operation are best qualified to judge of their effects. We quote the following extracts from the *Chino Champion*, written just after the close of the Chino factory campaign:

The manufacturing campaign commenced on August 2, and continued with no material interruption until October 18—78 days. During this time there were sliced 43,773 tons of beets, net, for which the factory paid \$202,694.54. Of this amount, \$155,455.31 was for Chino beets, and \$47,239.23 for beets from Anaheim and Buena Park, Orange county, shipped in by rail. This shows an average price of \$4.63 for the entire crop, being based on an average sugar percentage of 15. This is a most remarkable showing for the quality of the beets for the entire season—better, we believe, than has ever been made at any sugar factory in this country or in Europe.

The total sugar output for the season was 9,471,672 pounds, or 4,736 tons—473 car loads. In shipping this to the markets both barrels and bags were used, about 12,000 of the former being turned out from the cooper shop in connection with the factory. In the operation of the factory this campaign, there have been used 1,554,000 gallons, or 37,000 barrels, of oil in the furnaces, 1,350 tons of coke in the lime kilns, and 4,485 tons of limestone, besides 250 tons of burned lime received.

During the campaign an average of 300 men have been on the pay roll, and the total wages paid were \$65,000. The factory has, therefore, put in circulation direct, for beets and labor alone, \$267,684.64 during the past 80 days. Besides this, the industry has put large sums of money into circulation in payment for oil, coke, bags, barrels, chemicals, transportation, etc., the influence of which has reached and been felt in many localities all over Southern California. The channels of trade have been reached and commerce quickened by the vivifying touch of this, the greatest industrial enterprise in Southern California.

The Sacramento *Bee* gives the following statements regarding the amount of money put in circulation by a 334-ton plant:

Totals—Seventy-seven men during factory campaign, \$21,018; 43 men employed by the year, \$45,660. Total paid in wages at factory, \$66,678.

To produce 40,080 tons of beets, sufficient for 120 days' campaign, assuming that the farmer produces twelve tons to the acre, which only runs 14 per cent. saccharine matter, they will have cost to raise, \$2.07 per ton. Actual cost of labor, \$1.50 ton; seed, \$2.16 acre, 18 cents ton; rent land, \$10 acre, 83½ cents ton; delivery to factory, 50 cents ton; interest on farming tools, etc., 5½ cents ton; total cost per ton beets, \$2.07; 40,080 multiplied by \$2.07 equals \$82,965.60; total labor account, about \$150,000. To this you can add 20,000 tons Ione coal at \$1.75, \$35,000; 288 tons coke from your gas company at \$8, \$2,304; 2,400 tons lime rock from Folsom at \$2, \$4,800; total, \$42,104.

A sum of \$200,000 is not far from what a factory would pay out to labor for a capacity treating 334 tons of beets each day for 120 days.

Perhaps it would be well to consider how much profit there would be to the producers of these beets. Forty thousand and eighty tons at \$3.50 per ton for 12 per cent. beets, and forty cents for each 1 per cent. thereafter, would be \$4.30 a ton, or a clear profit to the raiser of \$2.23 a ton, after paying \$10 an acre rent for his land. On the year's crop there would be \$89,398.40 in profit to the farmers.

On an average I find that one man attends ten acres of beets, and the average for each ten acres is three persons, making about 1,000 inhabitants sustained directly by a 334-ton factory.

Status of the Beet Sugar Industry in the United States.

We are indebted to the report of the commission of internal revenue, sugar bounty division, for the fiscal year ending June 30, 1894, for the following statistical tables:

Quantity of beets used and sugar produced by the licensed beet sugar producers during the fiscal year ending June 30, 1894, and also the average yield of sugar per acre and per ton of beets used:

Names and locations of sugar producers.	Beets used.*		Sugar produced.†	YIELD OF SUGAR.	
				Per acre of beets...	Per ton of beets...
	Acres.	Tons.	Lbs.	Lbs.	Lbs.
California:					
Chino Valley Beet Sugar Co.....	4,171	49,353.8	15,063,367	3,611.4	305.2
Alameda Sugar Co.....	1,803	20,324.9	4,486,572	2,488.4	220.7
Western Beet Sugar Co.....	6,388	65,291.6	15,539,040	2,432.5	238.0
Total and av. yield in California..	12,362	134,970.3	35,088,969	2,838.5	260.0
Utah:					
The Utah Sugar Co.....	2,755	26,801.0	4,108,500	1,491.3	153.3
Nebraska:					
Oxnard Beet Sugar Co.....	1,671	11,149.0	1,835,900	1,098.7	164.7
Norfolk Beet Sugar Co.....	2,807	22,625.5	4,107,300	1,463.2	181.5
Total and av. yield in Nebraska..	4,478	33,774.5	5,943,200	1,327.2	176.0
Virginia:					
O. K. Lapham & Co.....	50	350.0	50,627	1,012.5	144.6
Grand total and average yield...	19,645	195,895.8	45,191,296	2,300.4	230.7

* Of the beets used, 22,051.1 tons, embracing an area of 2,878 acres, were cultivated by the licensed sugar producers themselves, while 173,844.7 tons, covering an area of 16,767 acres, were purchased by the sugar producers from contractors and neighboring farmers.

† A small quantity of the sugar produced was extracted from molasses carried over from the prior fiscal year, but as this additional production is about offset by sugar-producing material on hand June 30, 1894, it will not affect the correctness of the above computations.

Periods of operation and the average number of employes in such periods at the sugar factories of the licensed beet sugar producers during the fiscal year ending June 30, 1894:

Names and locations of sugar producers.	PERIODS OF OPERATION AT FACTORIES.*			Average number of employes.....
	Date of opening...	Date of final closing....	Actual number of days in operation,	
California:				
Chino Valley Beet Sugar Co.....	July 31, 1893	Nov. 4, 1893	97	149
Alameda Sugar Co.....	Sept. 18, 1893	Dec. 19, 1893	93	93
Western Beet Sugar Co.....	Sept. 14, 1893	Jan. 14, 1894	123	190
Utah:				
The Utah Sugar Co.....	Sept. 19, 1893	May 24, 1894	102	113
Nebraska:				
Oxnard Beet Sugar Co.....	Oct. 11, 1893	Nov. 28, 1893	49	184
Norfolk Beet Sugar Co.....	Aug. 29, 1893	Jan. 12, 1894	122	206
Virginia:				
O. K. Lapham & Co.....	Aug. 22, 1893	May 1, 1894	27	60
Total.....			613	995
Average number of days in operation and of employes at each factory.....			87.6	142.1

* All the beet sugar factories were operated at intervals both night and day during the periods stated, and the average number of employes given includes both night and day shifts of persons employed.

Quantity of granulated sugar estimated to be produced from masse cuite, yellow sugar and molasses on hand at the factories of the licensed beet sugar producers June 30, 1894:

<i>Names and locations of sugar producers.</i>	<i>Estimated production.</i>
	Pounds.
California:	
Chino Valley Beet Sugar Co.....	948,033
Alameda Sugar Co.....	1,108,367
Western Beet Sugar Co.....	149,943
Utah:	
The Utah Sugar Co.....	108,500
Nebraska:	
Oxnard Beet Sugar Co.....	557,031
Norfolk Beet Sugar Co.....	85,245
Virginia:	
O. K. Lapham & Co.....	None.
Total.....	2,957,119

Quantity and class of beet sugar produced and the amount of bounty paid thereon to the licensed sugar producers during the fiscal year ending June 30, 1894:

<i>Names and locations of sugar producers.</i>	SUGAR PRODUCED.			<i>Bounty paid.</i>
	<i>Testing less than 80 deg.</i>	<i>Testing less than 90 deg., but not less than 80 deg.</i>	<i>Testing not less than 90 deg.</i>	
	Pounds.	Pounds.	Pounds.	
California:				
Chino Valley Beet Sugar Co.....	23,490	15,039,867		\$263,197 66
Alameda Sugar Co.....			4,486,572	a 86,797 28
Western Beet Sugar Co.....		2,002,754	13,536,286	305,773 90
Total California.....	23,490	17,042,621	18,022,858	\$655,768 84
Utah:				
The Utah Sugar Co.....			4,108,500	b \$77,542 00
Nebraska:				
Oxnard Beet Sugar Co.....			1,835,900	\$36,718 00
Norfolk Beet Sugar Co.....			4,107,300	82,146 00
Total Nebraska.....			5,943,200	\$118,864 00
Virginia:				
O. K. Lapham & Co.....		19,091	31,536	(c)
Grand total.....	23,490	17,061,712	28,106,094	\$852,174 84

a Balance due July 1, 1894..... \$2,934 16

b Balance due July 1, 1894..... 4,628 00

c Amount allowed August 4, 1894..... 494 83

Total \$8,056 99

Amount paid..... 852,174 84

Total bounty on beet sugar crop of 1893-94..... \$860,231 83

c The amount of bounty claimed by O. K. Lapham & Co. was reduced \$469.98, covering 23,499 pounds of sugar testing not less than 90 deg., which was granulated from syrup produced without license and government supervision.

RECAPITULATION.

Licenses issued, the quantity of cane, beet, sorghum and maple sugar officially returned, and the amount of bounty and number of claims paid on these four kinds of sugar during the fiscal year ending June 30, 1894:

Kind of sugar.	Licenses issued.....	Sugar officially returned.....	Net bounty paid.....	Claims involved.....
		Pounds.		
Cane sugar.....	579	611,156,922	\$11,114,599 89	3,246
Beet sugar.....	7	45,191,296	852,174 84	62
Sorghum sugar.....	2	882,572	17,312 26	10
Maple sugar.....	5,761	7,633,608	116,121 90	4,628
Total.....	6,349	664,864,398	\$12,100,208 89	7,946

Net amount of bounty paid, by fiscal years, on each kind of sugar during the existence of the bounty law:

Sugar on which bounty was paid.	Net bounty paid in fiscal year ending June 30—			Net bounty paid from July 1 to August 27, 1894.	Total bounty paid.
	1892.	1893.	1894.		
Cane sugar.....	\$7,077,316 21	\$8,763,830 75	\$11,114,599 89	\$957,644 41	\$27,913,391 26
Beet sugar.....	240,098 56	531,363 81	852,174 84	8,056 99	1,631,694 20
Sorghum sugar.....	22,197 28	19,817 00	17,312 26	129 50	59,456 04
Maple sugar.....	2,465 74	60,119 32	116,121 90	354 94	179,061 90
Grand total.....	\$7,342,077 79	\$9,375,130 88	\$12,100,208 89	\$966,185 84	\$29,783,603 40

We have obtained by correspondence the following approximate statistics concerning the crop of 1894:

	Tons of beets used.	Pounds of sugar made.
Norfolk, Nebraska.....	27,500	5,500,000
Watsonville, California.....	125,000	.....
Chino, California.....	43,773	9,471,672
Lehi, Utah.....	33,000	5,500,000
Alvarado, California.....	39,769	5,910,095

In conclusion, we wish to express our thanks to any and all who have given us aid and coöperation in this work. Especially have we appreciated the favors extended by the press, and by the different lines of railroad operating in the state.

SUMMARY.

Sugar beet seed was distributed last spring to 1,015 farmers, representing every county in the state except Okanogan.

Sample beets for analysis were received from 384 different parties, representing 27 counties.

Seventeen hundred (1,700) samples were analyzed, coming from 101 different towns—45 being west of the Cascade mountains, and 56 in Eastern Washington.

The general state average of 1,666 analyses was as follows: Weight, 25 ounces; sugar, 14.2 per cent.; purity, 82.6.

The elimination of 122 analyses of a variety wholly unadapted to our state, gives for 1,544 analyses the following averages: *Weight, 22 ounces; sugar, 15.2 per cent; purity, 83.8.*

These results demonstrate that Washington can produce sugar beets of a very superior quality.

Sugar beet culture will be a very profitable industry for the farmer to engage in if he can find a market for his beets.

We have many inducements to capital to establish factories in the state.

The establishment of the beet sugar industry will have a far-reaching, stimulating, and beneficial effect upon our state.

Jan. 21, 1896

WASHINGTON STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE

EXPERIMENT STATION

PULLMAN, WASHINGTON

BULLETIN 16

DEPARTMENT OF AGRICULTURE

FEEDING EXPERIMENT NO. 1

FEEDING WHEAT TO HOGS

By **W. J. Spillman**

MARCH, 1895

All bulletins of this station are sent free to citizens of the state on application to the Director.

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FEEDING EXPERIMENT NO. 1.

FEEDING WHEAT TO HOGS.

W. J. SPILLMAN.

In view of the recent wide spread interest in the feeding of wheat, an experiment has been carried on at this station during the past winter, with a view to ascertaining the best method of feeding wheat to hogs. Incidentally, several other things of more or less importance have been brought out by this experiment. They will be discussed in the following pages.

The experiment was tried under such conditions as can be easily duplicated on any ordinary farm. The hogs used were grade Poland-Chinas and grade Berkshires, bought of a neighboring farmer when small pigs. Their exact ages are unknown to the writer. At the beginning of the experiment the average weight of the lot was $197\frac{1}{3}$ pounds, varying from $131\frac{1}{2}$ to $243\frac{1}{2}$ pounds, so that it may be said that the experiment was undertaken after the hogs had reached the usual limit of profitable feeding.

Previous to the experiment the hogs were fed kitchen slops, and whole wheat soaked in water. They had made good growth on this feed, and at the beginning of the experiment were in good condition, except that two or three of them were coughing. During the 56 days of the experiment they ate nothing but wheat, with what wood ashes and salt they would consume. Within a

week after the experiment began the coughing ceased, and every hog in the thirteen remained in apparently perfect health, and made fair gains till the end (except when on sheaf wheat, as noted later).

On October 20th the hogs were weighed and divided into four lots, the average weight in each lot being made as nearly equal as possible. The following table shows the weights, sex, and number of hogs in each lot, and the average weight of each lot :

LOT I.		LOT II.	
Pig No. 2, sow...	182 pounds.	Pig No. 8, sow.....	207½ pounds.
Pig No. 7, sow.....	196 pounds.	Pig No. 14, barrow..	220½ pounds.
Pig No. 12, barrow..	205 pounds.	Pig No. 16, barrow..	163 pounds.
Average.	194⅓ pounds.	Average....	197 pounds.
LOT III.		LOT IV.	
Pig No. 5, barrow...	233 pounds.	Pig No. 10, sow.....	191 pounds.
Pig No. 9, sow.....	178 pounds.	Pig No. 11, barrow ..	237 pounds.
Pig No. 15, sow.....	174 pounds.	Pig No. 13, barrow..	217½ pounds.
Average.....	195 pounds.	Pig No. 34, sow	137 pounds.
		Average.....	195⅝ pounds.

The time of the experiment was divided into three periods, as follows :

Period 1.	October 23d to November 7th.....	15 days
Period 2.	November 7th to November 27.....	20 days
Period 3.	November 27th to December 18th.....	21 days

Tests were made with wheat fed in five different ways, as follows :

1. Whole wheat, dry.
2. Whole wheat, soaked 12 hours in water.
3. Chopped wheat, dry.
4. Chopped wheat, soaked 12 hours in water.
5. Sheaf wheat.

The first of these rations was tried on two of the lots ; so also the second, and fifth. The third and fourth rations were tried on three lots.

The above facts are exhibited in the following table :

TABLE I.

Periods	Whole Wheat Dry	Whole Wheat Soaked	Chopped Wheat Dry	Chopped Wheat Soaked	Sheaf Wheat
1.	Lot I.	Lot II.	Lot III.	Lot IV.	
2.		Lot I.	Lot II.	Lot III.	Lot IV.
3.	Lot IV.		Lot I.	Lot II.	Lot III.

Each lot of pigs was placed in a pen containing about four square rods. In one side of each pen was a small house for shelter, open only on the east side. In each pen was a platform large enough for the hogs to stand on comfortably, and on this was a feeding trough, and also a watering trough in those pens where dry grain was the feed. The troughs were flat bottomed, six inches deep. Strips of wood were nailed from the outer edge of the trough to the fence, to prevent the hogs from getting into the trough. This is the most satisfactory of any of the plans for hog-feeding tried by the writer. The waste was small, and the food was not mixed with mud from the pigs' feet.

The food wasted by the hogs was no more than seems unavoidable; and as the object was to ascertain how much pork could be produced from a bushel of wheat under practical conditions, no account was taken of the waste. Food not eaten was left in the trough till next feeding, when a smaller amount was given. During the entire experiment the hogs were fed all they would eat.

The amount of wheat fed in the sheaf was estimated as follows: at threshing time, three separate observations were made as to the amount of wheat in 100 bundles (ordinary twine-bound bundles). The wheat in the three lots of 100 bundles each was 439, 431 and 454 pounds respectively; average, 441.3; or 4.413 pounds of wheat per bundle.

The hogs were fed twice a day, 7:00 a. m., and 6:00 p. m., all they would eat, and were watered three times a day.

By referring to Table I, it will be seen that at the end of period 1, lot II was taken off whole wheat diet and put on chopped wheat. The same occurred to lot I, at the end of period 2. In both these cases there was a marked falling off in the rate of gain for several days, undoubtedly due to the fact that the chopped wheat when first fed acted as a physic. It was noted during the whole of the experiment that hogs on whole wheat tended towards constipated condition of the bowels, while those on chopped wheat, and especially those on sheaf wheat, were in the opposite condition. In the case of hogs on chopped wheat, this loss at first was soon more than regained in rapid growth. For this reason, the first five days of Period 2, and the first six days of Period 3 (six days in the latter case because of inability to weigh the hogs on the previous day), are considered as preliminary, leaving the experimental parts 15 days in each of the three periods.

The following table exhibits the actual gains per head of each lot during each of the three periods :

TABLE II.

Periods	Whole Wheat Dry	Whole Wheat Soaked	Chopped Wheat Dry	Chopped Wheat Soaked	Sheaf Wheat
1.	14.9 Lbs.	17.2 Lbs.	26.9 Lbs.	21.8 Lbs.	
2.		22.7 Lbs.	23.2 Lbs.	23.1 Lbs.	5.5 Lbs.
3.	15.5 Lbs.		27.2 Lbs.	20.3 Lbs.	2.2 Lbs.
Averages	15.20 Lbs.	19.95 Lbs.	25.76 Lbs.	21.73 Lbs.	3.85 Lbs.

Table III shows the gains in pounds of pork per bushel of wheat eaten :

TABLE III.

Periods.	Whole Wheat Dry	Whole Wheat Soaked	Chopped Wheat Dry	Chopped Wheat Soaked	Sheaf Wheat
1.	9.7 Lbs.	9.1 Lbs.	12.7 Lbs.	11.9 Lbs.	
2.		11.3 Lbs.	12.4 Lbs.	11.8 Lbs.	3.7 Lbs.
3.	9.1 Lbs.		14.2 Lbs.	10.3 Lbs.	1.9 Lbs.
Averages	9.4 Lbs.	10.2 Lbs.	13.1 Lbs.	11.3 Lbs.	2.8 Lbs.

The uniformity of the results in each of these three periods is such as to give some measure of confidence in their correctness. It is, however, probable that the results obtained from the chopped wheat dry are a little higher than they would have been had the arrangement of the feeds and periods been different. As above stated, when hogs were placed on a diet of chopped wheat they lost for a few days in rate of gain, in several instances in actual weight, and then during a few succeeding days the gain would be unusually rapid. The preliminary periods of five days before period 2, and six days before period 3 were intended to counteract both these effects, but the writer is now of the opinion that the preliminary periods should have been longer. However, these remarks do not apply to any of the other four rations. The results with each of them are believed to be not far from what will be found in actual practice.

Another experiment will be undertaken during the present year to ascertain the relative value of dry and soaked chopped wheat as a hog feed.

It may be remarked that the high result with soaked whole wheat during period 2 is probably due largely to the individuality of the lot of hogs. During the last five days of the preceeding period, when they were on dry whole wheat, they made excellent gains and kept up these gains during the entire time of period 2.

Kind of Wheat Used.

With the exception of the sheaf wheat, the wheat used in this experiment was from the crop of 1893, and was so badly infested with stinking smut that local grain dealers would not buy it, nor would the local mills grind it for us. Yet, during the entire 56 days of the experiment every one of the 13 hogs has been in excellent health, except that some were coughing when the experiment began, as before noted.

Wheat and Corn Compared.

These hogs appear to have made large growth of bone and muscle. Their food has not gone much to fat, and they do not present the waddling appearance of corn fed hogs. While their gains have been fairly satisfactory, the heaviest are able to carry their flesh easily; in fact, the best one of the 13 is perhaps most active at the close of the experiment, and is not uncomfortably fat. There is little doubt that these hogs, after having their frame-work and muscles largely developed by wheat feed, would make better gains in the future on a more carbonaceous food, like corn meal. This experiment is not meant to demonstrate that wheat is the best feed for hogs, nor even that it is a good feed, but to ascertain in what manner it should be fed to make most economical gains.

Sheaf Wheat.

In this experiment, hogs that were changed from chopped wheat to sheaf invariably lost rapidly in weight, even when fed largely in excess of what they could eat. After a few days, however, they reached a level, near which they remained. It was demonstrated that hogs may be kept in fair condition, and poor hogs may be made to gain when fed sheaf wheat, but it can not be doubted that feeding sheaf wheat even to stock hogs, is wasteful in the extreme. Headed wheat would undoubtedly do better, and this will be given a trial during the next season. It is economical for a farmer to keep hogs to glean a wheat field after the crop has been removed, for the growth so made is utilization of a waste, but to cut wheat, straw and all, and feed them is not to be recommended.

Chopped vs. Whole Grain.

From table III it will be seen that whole wheat fed dry made on an average 9.4 pounds of pork per bushel of wheat eaten.

Whole wheat soaked 12 hours in water made 10.2 pounds of pork per bushel. The average of these two figures is 9.8 pounds. Chopped wheat fed dry made on an average 13.1 pounds, and the same soaked 12 hours in water made 11.3 pounds of pork per bushel eaten. The average of these figures is 12.2 pounds. Here then is a difference of 2.4 pounds of pork per bushel eaten in favor of grinding the grain. Under ordinary conditions this will more than pay for grinding.

It may be well to state that the grain in this experiment was ground as coarsely as convenient. It has been reported to me by farmers who have fed finely ground wheat, that the hogs were troubled with indigestion. Sufficient data are not at hand to settle this question. In the present experiment, with coarsely ground wheat no trouble of any kind was experienced, except as before noted—when hogs were changed from whole wheat diet to chopped wheat the feed invariably physicked them for a few days.

Effect of Soaking the Feed.

In feeding whole wheat to hogs, whether fed dry or soaked 12 hours in water, large amounts of the feed came through in the manure undigested. The fact that the soaked wheat made better gains than the dry, however, seems to indicate that soaking whole wheat increases its digestibility. On the other hand, chopped wheat did better dry than soaked. As explained above, this may be due to the fact that unusual gains were recorded for a few days after the loss occasioned by changing from whole to chopped feed, and the experiment was so arranged that this would affect only the dry chop. Yet, as before stated, each period was preceded by a preliminary period of 5 or 6 days, in order to avoid error due to change of feed. There is another possible explanation of this result. Wheat is largely starch, and saliva is one of the juices that digest starch. In eating dry grain more saliva is swallowed than in eating soaked grain, and hence the food is more completely digested. This would not apply so forcibly in the case of whole wheat; for while more saliva would be swallowed in eating it dry, the dry whole grains would not be permeated by the saliva to any great extent.

For those who desire to examine the details of the experiment they are given in the self-explanatory tables which follow:

TABLE IV.—LOT I.

1894.	Weights—10.00 a. m.			Wt. of 3 hogs, Pounds	Days since last weigh d	Gain since last weigh d	Daily gain per head	Kind of feed.	Am't eaten lbs.	Daily feed per h'd lbs.	Pounds eaten per lb of gain
	Pig No. 2.	Pig No. 7.	Pig No. 12.								
October 23.....	182	202½	207	591½	10	28	9.3	Whole wheat dry	196¼	6.54	7.01
November 2.....	191	207½	221	619½	5	16¾	1.12	Whole wheat dry	81	5.40	4.83
November 7.....	198¼	210	228	636½	5	21	1.40	Whole wheat dry	110	7.33	5.24
November 12.....	201	220¾	235½	657¼	5	21¾	1.45	Whole wheat soaked	117	7.80	5.48
November 17.....	209½	227½	242½	679	6	25	1.39	Whole wheat soaked	153	8.50	6.12
November 23.....	220¾	234½	248½	704	4	21¼	1.77	Whole wheat soaked	90	7.30	4.23
November 27.....	229¾	236	259½	725¼	4	21¼	—	Whole wheat soaked	106	5.89	.....
December 3.....	222½	240¼	254½	734	6	50	3.33	Dry chop	104	6.93	2.08
December 8.....	341½	252¼	270	767¾	5	17	1.13	Dry chop	120	8.00	7.06
December 13.....	253¼	258¾	272¾	784¼	5	17	1.13	Dry chop	120	8.00	7.06
December 18.....	262½	258½	277¾	798¾	5	14½	.97	Dry chop	120	8.00	8.27

TABLE V.—LOT II.

1894.	Weights—10.00 a. m.			Wt. of 3 hogs, Pounds	Days since last weigh d	Gain since last weigh d	Daily gain per head	Kind of feed.	Am't eaten lbs.	Daily feed per h'd lbs.	Pounds eaten per lb of gain
	Pig No. 8.	Pig No. 14.	Pig No. 16.								
October 23.....	214½	222½	162½	599½	10	37	1.23	Whole wheat soaked	232	7.73	6.27
November 2.....	228½	233½	173½	635½	5	14½	.97	Whole wheat soaked	109	7.27	7.52
November 7.....	235	237½	177½	650	5	11½	1.75	Dry chop	125	8.33	11.11
November 12.....	239½	242¼	179	661¼	5	16½	1.10	Dry chop	122	8.13	7.39
November 17.....	247	248½	182¼	677¾	5	40½	2.25	Dry chop	144	8.00	8.55
November 23.....	261½	262	195¼	718¼	4	12¾	1.06	Dry chop	72	6.00	5.65
November 27.....	262¼	268	200¾	731	4	28	1.56	Soaked chop	150	8.33	5.36
December 3.....	273	277¼	208¼	759	6	23½	1.57	Soaked chop	118	7.87	5.02
December 8.....	281	288½	213	782¼	5	19	1.27	Soaked chop	118	7.87	6.21
December 13.....	286	290½	220	801½	5	18½	1.23	Soaked chop	120	8.00	6.48
December 18.....	294	303	323	820	5	18½	1.23	Soaked chop	120	8.00	6.48

TABLE VI.—LOT III.

1894.	Weights—10.00 a. m.				Wt. of 3 hogs, Pounds	Days since last weighd	Gain since last weighd	Daily gain per head	Kind of feed.	Am't eaten lbs.	Daily feed per h'd lbs.	Pounds eaten per lb of gain
	Pig No. 8.	Pig No. 9.	Pig No. 10.	Pig No. 15.								
October 23.....	251½	183	171	187½	585½	10	50½	1.68	Dry chop	217	8.23	4.89
November 2.....	250	198½	187½	198½	636	5	30½	2.02	Dry chop	136	9.07	4.49
November 7.....	259¾	208¼	198¼	208¼	661¼	5	16½	1.08	Soaked chop	120	8.00	7.38
November 12.....	271	209	202½	202½	682½	5	21¾	1.45	Soaked chop	116	7.73	5.83
November 17.....	280½	218¾	205	217½	704½	5	35¾	1.99	Soaked chop	139	7.72	3.89
November 23.....	291¾	230¾	217½	217½	740	6	11¾	.98	Soaked chop	96	8.00	8.17
November 27.....	296	232	223¾	223¾	751¾	4	—30¼	—1.68	Sheaf wheat	86	4.78	.....
December 3.....	283	223¾	219¾	219¾	721¼	6	1	.07	Sheaf wheat	66.2	4.41	66.20
December 8.....	283¼	223	216¼	216¼	722¼	5	—3¾	— .25	Sheaf wheat	57.4	3.83	57.4
December 13.....	278	221	219¾	219¾	718¾	5	—3¾	— .25	Sheaf wheat	57.4	3.83	57.4
December 18.....	280¾	222¾	224½	224½	728	5	49¼	.62	Sheaf wheat	83.8	5.59	9.07

TABLE VII.—LOT IV.

1894.	Weight—10.00 a. m.				Wt. of 4 hogs, Pounds	Days since last weighd	Gain since last weighd	Daily gain per head	Kind of feed.	Am't eaten lbs.	Daily feed per h'd lbs.	Pounds eaten per lb of gain
	Pig No. 10	Pig No. 11.	Pig No. 13.	Pig No. 34.								
October 23.....	191½	243½	222½	131½	789	10	55	1.38	Soaked chop	288	9.6	5.24
November 2.....	206	261	236½	140½	844	5	32	1.60	Soaked chop	148	9.87	4.62
November 7.....	211½	269½	246¼	149	876	5	—29½	—1.48	Sheaf wheat	154.5	10.30	.....
November 12.....	203	256	241	146½	846½	5	41½	.49	Sheaf wheat	154.5	10.30	.....
November 17.....	204½	257½	242	147½	851½	5	11¾	.36	Sheaf wheat	158.9	8.30	.....
November 23.....	210	260½	242½	149¾	862¾	6	35¾	1.03	Sheaf wheat	167	2.61	.....
November 27.....	212¼	263½	246	152¼	868¾	4	24¾	1.03	Whole wheat dry	167	9.28	6.74
December 3.....	215	269½	248¼	160	893¼	6	24¾	2.14	Whole wheat dry	129	8.60	3.02
December 8.....	227	277¾	261¾	169¾	936	5	4¾	.24	Whole wheat dry	140	9.33	29.7
December 13.....	230¼	284	264	168¼	940¾	5	8¾	.44	Whole wheat dry	141	9.40	15.1
December 18.....	236½	280½	264½	174	955¼	5	8¾	.44	Whole wheat dry	141	9.40	15.1

Summary.

1. Feeding sheaf wheat to hogs is a wasteful practice; even under the best conditions a large amount of grain is wasted; and the hogs can not find enough grain to fatten on rapidly. Feeding headed wheat would doubtless be less wasteful, but data are not yet at hand for determining this point.

2. Soaking whole wheat in water for 12 hours increases its digestibility, so that it will produce about one pound more pork per bushel eaten.

3. Wheat coarsely chopped and fed either dry or soaked 12 hours in water, gives larger returns than whole wheat. Under the conditions of this experiment, the increase was sufficient to more than pay for the chopping.

4. Dry chopped wheat gave a larger yield of pork than soaked chop, but this may have been due to the order in which the feeds were given each lot.

5. With hogs weighing less than 250 pounds, a bushel of chopped wheat will produce about 12 pounds of pork; hence,

If it costs $4\frac{1}{2}$ cents a bushel to chop wheat, it pays to feed wheat to hogs when the following prices obtain:

Pork 3 cents, and wheat less than 31 cents.

Pork $3\frac{1}{2}$ cents, and wheat less than $37\frac{1}{2}$ cents.

Pork 4 cents, and wheat less than $43\frac{1}{2}$ cents.

Pork $4\frac{1}{2}$ cents, and wheat less than $49\frac{1}{2}$ cents.

Pork 5 cents, and wheat less than $55\frac{1}{2}$ cents.

6. With wheat at 24 cents a bushel, pork can be produced at a cost of $2\frac{1}{3}$ cents a pound. Wheat at $19\frac{1}{2}$ cents a bushel produces pork at a cost of 2 cents a pound.

Jan. 21, 1896.

WASHINGTON STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE

EXPERIMENT STATION

PULLMAN, WASHINGTON

BULLETIN 17

All bulletins of this station are sent free to citizens of the state on
application to the Director

DEPARTMENT OF BOTANY AND ZOOLOGY

INSECT PESTS OF THE GARDEN, FARM AND ORCHARD

By C. V. Piper

1895

SEATTLE, WASH.
THE CALVERT COMPANY

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INTRODUCTION.

The main object of the present bulletin is to furnish information on the more common injurious insects of the state, and such others recently introduced which threaten to become serious pests. The need of this information has been well shown in the amount of correspondence received relative to nearly every insect described herein, and which has added not a little to the work of the entomologist.

Nearly all of our common destructive insects have been introduced from other states; such of them as are native are for the most part the same or closely related species to those that have long been studied and combatted in other states. Consequently only a relatively small portion of the information presented here is original.

The form in which the subject matter is arranged is the same as that used by Mr. V. L. Kellogg in his "Injurious Insects of Kansas." It is adopted first because for the use of most farmers and orchardists it furnishes the easiest and quickest way to identify a pest; second, under "Washington Notes" we are able to give separately the history of each in this state, and to make special suggestions.

To render the identification of insects more easy, those described here are numbered, and a host index given showing which insects are to be found on each particular plant. It is not to be supposed that all the injurious insects of the state are treated of in this bulletin. There is a large number both of native and introduced insects, each of which does slight damage every year, and in the case of a few, serious damage in some seasons. Many of these will be described in another bulletin soon to be issued.

A thorough knowledge of all our injurious insects can soonest be obtained with the earnest co-operation of all the farmers and orchardists in the state, and we cordially invite correspondence concerning any insect, injurious, beneficial, or otherwise, and such correspondence will always receive prompt attention. Inquiries concerning insects should be accompanied by specimens, the more the better.

DIRECTIONS FOR SENDING INSECTS.

Adult insects should first be killed, which can best be done by putting them in a tight jar with a few drops of chloroform. Then place the specimens in a close tin or wooden box, packing them in cotton or some other soft material, so that they will not be broken.

All larval forms should be sent alive, care being taken to put with it a supply of its food plant, enough to last at least two days. Do not punch holes in the box, as insects require very little air. If it is not convenient to send the larva alive, kill it in alcohol and pack in cotton saturated with alcohol. The mailing rate on all packages of insects is one cent per ounce. To accompany the specimens, write a letter containing all particulars concerning the insects, such as the date of its appearance, numbers, the part of the plant attacked, whether root, stem, leaf, flower or bud, the remedies, if any, which you have tried; and, indeed, any notes whatsoever concerning the insect. These may be of great practical as well as of scientific value. All packages should have the name of the sender plainly written on the outside, and should be addressed to the Entomologist, Agricultural Experiment Station, Pullman, Washington.

ACKNOWLEDGMENTS.

We are under obligations for the use of electrotypes to Prof. Lawrence Bruner, of the Nebraska Station; to Prof. C. P. Gillette, of the Colorado Station; to Mr. M. V. Slingerland, of the Cornell Station; to Messrs. Lippincott & Co., Philadelphia; to Secretary of Agriculture Morton; to Prof. Clarence M. Weed; and to Secretary C. A. Tonneson, of the State Board of Agriculture.

The original sources of the cuts is as follows:

After Riley: Figures 1, 2, 7, 11, 12, 13, 22, 23, 24, 30, 33, 40, 51, 52, 50, 53, 48.

After Saunders: Figures 3, 4, 5, 8, 9, 10, 14, 15, 25, 29, 27, 31, 32, 39, 40.

After Harris: Figures 28, 29.

After Slingerland: Figures 16, 19, 20, 21.

After "Insect Life": Figures 34, 35, 36, 37, 38.

After Weed: 120, 121, 107, 108.

INSECT PESTS OF THE GARDEN, FARM AND ORCHARD

BY C. V. PIPER.

SOME FACTS ABOUT INSECTS.

That the orchardist, or farmer may *intelligently* combat insect pests, some knowledge of the wonderful transformations of insects in general is necessary, as well as the particular life history of each separate pest ; and with this a thorough understanding of the few technical terms whose use is unavoidable.

Insects may easily be distinguished from all related animals by the mere fact that they possess *three* pairs of legs ; spiders and most mites have *four* pairs of legs, and are not insects.

The great majority of insects pass through four more or less distinct stages of existence ; *first*, the *egg* ; *second*, the *larva*, variously known as caterpillar, grub, maggot, borer, and commonly but not properly as "worm." True worms, such as the earth-worm and leech, never change into insects ; *third*, the *pupa*, in most insects quiescent, and either naked or covered with a *cocoon* ; the pupa of a butterfly is sometimes called a *chrysalis* ; in many other insects, such as the grasshopper and plant bugs, the pupa remains active, and differs from the larva only in possessing rudimentary wings ; such active pupæ are called *nymphs* ; *fourth*, the perfect insect or *imago*, whether fly, bug, beetle, ant, butterfly, or

bee. Nearly all insects pass through the four stages described. When as in the case of the butterfly and bee, the pupa is quiescent, the transformations form a *complete metamorphosis*; when the pupa is active as in bugs and locusts, the metamorphosis is *incomplete*.

Some few insects do not pass through a metamorphosis at all, but the young, hatched from the egg, or in some cases born alive, closely resemble the parent; in the plant lice or *aphididæ*, the life history is peculiar, and is treated of in detail in the consideration of these insects.

Many insets are destructive only in the larval stage (caterpillars, grubs, maggots, borers), and all insects with a complete metamorphosis grow only in this stage. The pupæ of insects with a complete metamorphosis never feed, but when they remain active (nymphs) as in the bugs and grasshoppers, they continue to feed and grow, and are quite as destructive as the larvæ.

The adult insects or *imagoes*, are also frequently injurious (beetles, grasshoppers, bugs). In most cases an insect is injurious only in one of its stages, usually the larval; in others both the larvæ and adults do the damage, and in a few (grasshoppers, bugs), larvæ, pupæ and adults are all destructive.

It must be understood that the term injurious insect is a purely relative one. Commonly by injurious insect we mean those that damage plants, animals, or stored products useful to man; if on the other hand they tend to destroy weeds or noxious animals, they are indirectly beneficial. Usually, however, the term "beneficial insects" is applied to those that destroy noxious insects; on the other hand, any enemy to the beneficial insect, becomes indirectly injurious. To illustrate, the ladybird beetles are beneficial because they destroy myriads of injurious plant lice; several parasitic insects, however, destroy the ladybird and thus become indirectly injurious. However, this last matter is largely beyond our control.

BENEFICIAL INSECTS.

Of these there are, according to their habits, two distinct classes, the *predaceous*, which capture and eat their prey, and the *parasitic*, which deposit their eggs in or on the bodies of their

victims (called technically the *host* of the parasite) ; these eggs hatch into larvæ which feed on the body juices of the host, finally killing it. Most parasites deposit their eggs in or on the larval stage of their host, which gradually succumbs to the attack of the parasite, usually, however, retaining strength enough to change into a pupa before dying. Inside the body of the victim, the parasite passes through the larva and pupa stages, finally emerging as a perfect insect. Other parasites lay their eggs in the pupæ or even in the imagoes of their hosts ; and many minute forms, called *egg-parasites*, lay their eggs in the eggs of other insects.

Among the most useful of the predaceous insects are the ladybirds (Fig 1). Both in the adult and laval stages, ladybirds destroy great numbers of plant lice, young scale insects, and other soft bodied forms.



FIGURE 1.—Convergent Lady Bird. Larvæ, pupa, wings.



FIGURE 3.—Ground Beetle, (*Harpalus caliginosus*).



FIG. 4—Tachina.

Hardly less efficacious than the ladybirds in destroying plant-lice is *Chrysopa*, the golden-eye or lace-wing fly, (Fig. 2), a beautiful pale-green insect. Only in its larval stage is it predaceous, the larva being provided with large sharp jaws.

The common black ground beetles are also very useful insects, destroying large numbers of grubs and other soft bodied insects. A very familiar species is shown in Fig. 3.

Among the parasitic insects which do much to lessen the loss to farmers, are the Tachina flies (Fig. 4). These resemble quite closely in form the common house fly. They are all parasites, mostly in the bodies of caterpillars.

The immense family of Ichneumon flies are also *all* parasites. Two common species, shown in Figs. 5 and 6, do much to keep down the numbers of various caterpillars. Other minute species lay their eggs in the bodies of plant lice and other small insects, thus destroying hosts of them. It is a matter of common observation that years of abundance of an insect is apt to be balanced by one or more years of scarcity. This is mainly owing to the work of parasites.

The closely related minute *chalcid* flies also destroy great numbers of insects.



FIGURE 2.—Lace Wing Fly. *a*, eggs; *b*, larva; *c*, mature insect.

DISEASES.

Several diseases caused by low fungus plants also destroy many insects, especially in wet seasons. Some of these diseases have been used with considerable success in combatting pests.

INSECTICIDES OR INSECT KILLING SUBSTANCES.

While beneficial insects and diseases do much to keep down the numbers of pests, yet these latter very often increase to such an extent that they must be vigorously combatted with insecticides.

There are two principal classes of insecticides, namely, those that kill by being swallowed with the food, *internal poisons*, and those that kill through contact, either by their irritating properties, or by closing the breathing pores of the insect, or by both effects, *external poisons*.

Insecticides of the first class are to be used only for *biting insects*, those that bite and chew their food; those of the second class mainly for *sucking insects*, those that take their food in a liquid form only. In some cases, external insecticides can be used to good advantage against biting insects.

Sucking insects obtain their food from the juices of the plant by inserting their sharp beaks into the tissues of the plant. It is manifestly useless, therefore, to spray plants with an *internal in-*



FIGURE 5.—Ichneumon Fly. (*Pimpla conquisitor*).



FIG. 6.—Ichneumon Fly. (*Ophion bilineatus*).

secticide for such insects, as the insect's food, the sap or other juices of the plant, is not reached at all by the poison.

So likewise it is useless to spray with an external poison for such biting insects as the borers, simply because the poison does not reach the part of the plant on which they are feeding.

INTERNAL, OR FOOD POISONS; THE ARSENICALS.

Two poisons, namely, Paris Green and London Purple, have displaced all other substances as the ordinary insecticides for biting insects. They are both heavy powders, the former bright green in color, the latter dull purple. In each case the active poison is *arsenic*, of which they both contain about sixty per cent. The amount is less apt to vary in Paris Green than in London Purple. The former is the stronger insecticide and acts more quickly; the latter remains better suspended in water, and is cheaper. Paris Green costs about 20 cents a pound in quantities; London Purple about half that amount. White arsenic, which is sometimes recommended, should *never* be used. It is not only

dangerous to have around, but burns foliage very readily when used.

HOW TO USE THE ARSENICALS.

The Wet Method.—In this, the standard method, the poison is applied in a spray, using one pound of the poison to 150 gallons of water for all plants except the plum and the peach; for these two the strength should not exceed one pound of the poison to 250 gallons of water, otherwise the foliage will be scalded.

To prepare the spray, the poison should first be mixed into a fine paste with a small amount of water, and an equal amount of good lime added. The mixture may then be washed through a strainer into the spray tank and the proper amount of water added. With London Purple the lime *must always be used*; it is desirable but not necessary with the Paris Green also.

The Dry Method.—This consists in dusting the poison on the plants in a dry form, diluting it first by *thoroughly* mixing with flour, air-slaked lime or dust. It is to be applied to the plants, preferably in the early morning, when wet with dew, by sifting through a piece of course cheese cloth, or with a powder gun. A convenient form of sifter is a joint of stove-pipe, with the cheese cloth tied over one end.

We recommend this method for cabbage insects, for which one pound of the poison is to be mixed with fifty pounds of flour or dust, or a like proportion in smaller amounts. The last application should not be made later than ten days before the cabbage is to be used, and in this application use in the proportion of one pound of poison to 100 pounds of flour. In applying use just enough so that it is plainly visible on the whole plant.

For young plants of various kinds, attacked by flea beetles, use one pound of the poison to fifty pounds of flour, and use freely.

CONTACT OR EXTERNAL INSECTICIDES.

Kerosene Emulsion is still the leading insecticide of this class.

KEROSENE EMULSION—THE STANDARD FORMULA.

Kerosene	2 gallons
Whale oil soap (or 1 qt. soft soap)	½ pound
Water	1 gallon

The soap is to be dissolved by boiling in the water, which is then added, boiling hot, *away from the fire*, to the kerosene. The whole mixture is then violently agitated by being pumped back on itself with a force pump through an ordinary one-eighth-inch nozzle. Most forms of spray pumps answer this purpose admirably. After four or five minutes pumping, the mixture will have a thick creamy consistence, and if well made will stand indefinitely without free oil rising to the top.

Hard soap may be used instead of the whale oil, but it is desirable to use a good quality, such as Ivory soap. The best results, however, are obtained from using whale oil soap.

Unless otherwise stated, the kerosene emulsion is to be used dissolved in water, in the proportion of one gallon of the emulsion to 12 gallons of water.

KEROSENE AND MILK EMULSION.

When only a small amount of kerosene emulsion is needed it may be quickly be made as follows :

Kerosene.....	2 quarts
Sour milk.....	1 quart

Mix the two without heating and churn thoroughly as in ordinary kerosene emulsion. The mixture emulsifies into a very thick cream after four or five minutes agitation. Dilute with twelve parts water before using.

SULPHUR, SALT AND LIME WASH.

Lime.....	50 pounds
Sulphur.....	25 pounds
Salt.....	18 pounds
Water to make.....	100 gallons

Take 15 pounds of lime and 25 pounds of sulphur, and boil with 20 gallons of water for about two hours, when the sulphur should be dissolved and the liquid of a deep amber color. While boiling, the liquid should be frequently stirred.

Slack the rest of the lime in another cask, using preferably hot water, and while it is boiling add the salt, and stir until it is dissolved. Then add this to the lime and sulphur solution in the boiler, and boil for another half hour, after which water sufficient to make the 100 gallons is to be gradually added, stirring meanwhile.

In spraying, use a pump with an agitator so that the solution is kept constantly stirred. This wash is to be used *only when the leaves are off the trees*.

RESIN SOLUTION.

Summer Formula.

Resin.....	20	pounds
Crude Caustic Soda...	5	pounds
Fish oil.....	2½	pints
Water to make.....	100	gallons

Winter Formula.

Resin	30	pounds
Crude Caustic Soda.....	8	pounds
Fish oil.....	4	pints
Water to make.....	100	gallons

Place the resin, soda and oil in a kettle, cover with three or four inches of water and boil two hours or more, when the substance will be dissolved, and the mixture resembles black molasses. Add the rest of the water, preferably *warm*, gradually to the mixture, stirring meanwhile.

The summer formula is useful for plant lice, young scale insects, etc.

The winter formula gives excellent results, where not wet too often by rains, as a winter spray for scale insects.

WHALE-OIL SOAP.

Simple solutions of this substance of varying strength, are fatal to many insects. Mr. L. O. Howard found that a solution of two pounds to one gallon of water was fatal when applied as a winter wash to the San Jose scale, one of the most difficult insects to kill.

PYRETHRUM OR BUHACH.

This is a fine yellow powder, having a pungent odor, made from the flowers of a chrysanthemum-like plant. While deadly to most insects it is perfectly harmless to man. It is much better fresh, as in time it loses the volatile oil on which its insecticide qualities depend. For this reason Buhach, a brand made by the Buhach Manufacturing Co., Stockton, Cal., is to be preferred. It may be used by dusting over the plants, first diluting with four times its bulk of flour. In this case the mixture should be kept in a tight jar a day or two when the entire mass will be nearly as good as the pure powder. Or it may be applied as a liquid spray, using one ounce Buhach to three gallons of water. Buhach costs about 60 cents a pound, which prevents its more extensive use. It is used mainly for cabbage insects, or wherever there may be danger from using a poisonous insecticide.

HELLEBORE.

This substance comes in the form of a finely ground white powder, selling for about 60 cents a pound in quantities. It is similar in its action to Buhach, and is especially useful against the cherry slug. Use dry diluted with four or five times its bulk of flour ; or as a watery solution, using one ounce of the Hellebore to four or five gallons of water.

CARBON BISULPHIDE.

This is a heavy, ill-smelling liquid, the vapor of which is quickly fatal to all life. *It is very explosive, and must be kept away from the fire or from any other flame or spark.*

It has been used with much success for such subterranean insects as borers, cabbage maggots and the root form of the woolly aphis.

To use it for such insects, punch small holes in the ground a foot or so deep near the roots of the affected plants, and pour a small quantity of the liquid in each, afterwards covering the holes with earth. The vapor penetrates through the soil and kills the insects. Large quantities of it must not be used, as it also destroys plant life.

COMBINED INSECTICIDE AND FUNGICIDE.

It is sometimes desirable to spray for both insects and fungus diseases at the same time. This can be done in the case of biting insects, by adding one pound of Paris Green or London Purple to 200 gallons of the fungicide known as Bordeaux Mixture.

Bordeaux Mixture is best made by the following formula :

Copper Sulphate (Bluestone).....	6 pounds
Fresh Lime	4 pounds
Water.	50 gallons

First dissolve the bluestone in 30 gallons of water. This is more easily done if the bluestone is suspended in the water in a piece of coarse cloth or sacking. Slack the lime carefully in a small quantity of water, slowly adding enough of the latter to make a creamy liquid. Then pour this slowly into the bluestone solution, with enough water to make the 50 gallons, stirring continually.

If properly made the mixture will have a deep sky-blue color.

A very convenient test for Bordeaux mixture is made with a

weak, watery solution of yellow prussiate of potash, made by dissolving one ounce of the latter in a pint of water. If the Bordeaux mixture is properly made there will be no change when a drop or two of the potash solution is added to it; if however there is not enough lime, a brownish color appears whenever the potash solution drops in the Bordeaux mixture. When this is the case more lime should be added until no brown color appears upon repeating the test.

Bordeaux Mixture must be used fresh.

HOST INDEX OF INSECTS DESCRIBED HEREIN.

Attacking the Apple	Nos. 1, 2, 4, 5, 6, 8, 11, 12, 13, 14, 16, 17, 18, 21, 22, 28
Attacking the Pear	Nos. 5, 10, 14, 17
Attacking the Plum	Nos. 2, 4, 5, 11, 12, 13, 14, 16, 17
Attacking the Peach	Nos. 13, 14
Attacking the Cherry	Nos. 3, 9, 13, 14, 17, 23
Attacking the Currant	Nos. 4, 14, 15, 17, 19
Attacking the Strawberry	No. 34
Attacking the Raspberry	Nos. 2, 14
Attacking the Blackberry	No. 14
Attacking the Grape	Nos. 14, 17
Attacking the Cabbage	Nos. 12, 25, 29, 30, 31, 32, 33, 34
Attacking the Tomato	No. 12
Attacking the Rose	Nos. 2, 4, 5, 14, 16, 17, 19, 28
Attacking various shade and ornamental trees	Nos. 4, 5, 6, 11, 12, 14, 17, 20, 26, 27

NO. 1—THE CODLING MOTH (*Carpocapsa pomonella*).

Diagnosis.—Infesting the fruit of the apple and pear; a small pinkish larva which burrows into the fruit and discloses its presence by brownish castings which it ejects from a hole in the fruit; many of the attacked apples fall prematurely to the ground.

Description and Life History.—The larva is the young of a small purplish-brown moth shown in Fig. 7. It measures a little more than half an inch from tip to tip. The first moths appear at the time the apple trees are in bloom, or a little later, when the females deposit their eggs singly in each blossom, or on the blossom end of the young apple. Each female is capable of laying forty or fifty eggs. In from six to nine days these eggs hatch into minute larvæ or "worms" which at once begin to burrow to

the core of the apple. Arriving there when half grown, the "worm" feeds mainly on the young seeds, toward which it is very partial. The castings are thrown out through the same hole by which the worm entered, or more frequently through a horizontal hole bored to the side. These castings are of a rusty reddish color, and make the wormy apples quite easy to detect at this time. In about four weeks' time the "worm" or larva reaches its full size and then leaves the apple either by crawling out of the hole and thence on to the tree, or by dropping to the ground on a silken thread which it spins; many of the infested apples drop to the ground, and not rarely this happens before the larva has attained its full growth. In such case, the worms crawl out of the apple almost immediately, and most of them reach the trunks of the trees, up which they crawl.

The larvæ seek for protected places, such as crevices in the bark, and there spin a thin cocoon in which they soon change to brownish pupæ. In from fourteen to eighteen days, the adult moths of the second brood emerge, and a few days later eggs are laid from which a third brood develops. Usually the larvæ of the third brood become mature late in fall, and strangely enough spin a cocoon in which they hibernate in the larval condition, not changing to pupæ until the following spring. The moths fly mainly at night, and are never attracted to lights.

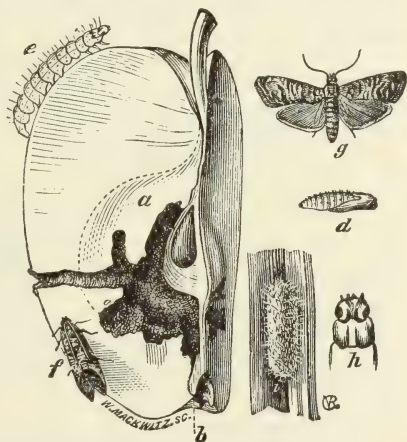


FIG. 7.—Codlin Moth: *a*, burrowings of larva; *e*, larva; *f*, moth, wings closed; *g*, moth, wings expanded; *h*, head of larva; *i*, cocoon.

Remedies.—I. The arsenicals furnish by far the best remedy for this insect. The trees should be sprayed first within a few days after the petals fall from the blossoms, *never before*. A second spraying should be given two weeks later. The object is to keep the growing apples covered with the poison, so that the young worm becomes poisoned the moment it begins to burrow

into the apple. As a rule two applications are sufficient, but if necessary a third may be given two weeks after the second.

2. Advantage is taken of the habit of the larvæ of pupating in sheltered places on the trunk, by preparing suitable places to which they are attracted to pupate, and in which they may easily be destroyed. The simplest method is the so-called "band system." This consists simply of fastening a strip of burlap around the trunk a foot or so above the ground. The burlap should reach twice around the trunk and may be fastened with a nail. If the trunk of the tree is kept clean and free from loose bark, nearly all the larvæ which escape the spraying, will pupate beneath the burlap band and may there easily be killed. The bands should be examined every two weeks. If a longer time elapses, some of the moths will have emerged from the pupæ and have escaped. Especial care should be taken to examine the bands after the leaves have fallen in autumn and before the buds burst in spring, so that all the hibernating individuals may be destroyed. The danger from the first brood is thus largely lessened.

The use of these two methods together, furnishes the best known remedy for this insect.

Washington Notes.—Very destructive throughout the state. Some growers make a practice of spraying every two weeks throughout the season. While this furnishes almost complete immunity from the attacks of this insect, it is seriously to be doubted if the applications after the third or fourth will save enough more apples to pay for the cost of the additional sprayings.

NO. 2—THE OBLIQUE-BANDED LEAF-ROLLER.

(*Cacæcia rosaceana*).

Diagnosis.—Infesting the apple, pear, plum, cherry, raspberry, currant, and other shrubs; leaves rolled up into tubes and tied by silken threads, in which the small green larvæ feed and are sheltered.

Description and Life History.—The mature insect is a small moth, spreading about one inch. When the wings are closed the moth resembles a tall helmet in outline (Fig. 8); when open, the front of the fore-wings is seen to be doubly curved (Fig. 9). The fore-wings are dull, reddish brown in color, crossed by three

oblique darker bands ; the hind wings are dirty yellow. Soon after the leaves unfold in spring, the larvæ (Fig. 10) hatch out, and at once roll up leaves in which they live and feed. When disturbed they have the habit of wriggling out quickly and dropping to the ground by a fine thread. They become fully grown in June, and are then about three-fourths of an inch long, pale green in color, with a darker stripe along the back. In the leaf-tube the larvæ now transform into brownish pupæ. Before these hatch they wriggle partly out of the open end of the nest, so that after the moth has emerged, the brownish pupa skins are quite conspicuous. There is but one brood a year.

Remedies.—Spray with Paris Green or London Purple, shortly after the leaves unfold.

Washington Notes.—Common throughout the state and sometimes very abundant, especially on plums and prunes. In some seasons it is one of our most injurious insects.



FIG. 8.—Oblique-banded Leaf-roller; moth, wings closed.



FIG. 9.—Oblique-banded Leaf-roller; moth, wings spread.

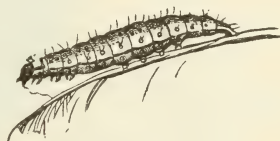


FIG. 10.—Oblique-banded Leaf-roller. Upper figure, larva ; lower figure, pupa.



NO. 3.—THE CHERRY LEAF-ROLLER. (*Cacoecia cerasivorana*).

Diagnosis.—Small greenish caterpillars on the choke-cherry, and less frequently on the cultivated cherry, tying the leaves of the terminal twigs into great nests by means of numerous silken threads.

Description and Life History.—The adult is very similar to the preceding insect. The fore wings are bright shining yellow more or less marked with brown splotches ; the hind wings are a paler yellow. The eggs are laid in large numbers in circular masses, and are covered over with a brownish glutinous substance. They hatch shortly after the leaves appear in spring into minute green larvæ, which at once proceed to tie up the leaves into large

nests, in which they remain. As the larvæ grow older they continually enlarge the size of the nest by tying new leaves and twigs to it. The fully grown larvæ measure three-fourths of an inch in length, are dirty greenish in color excepting the head, first segment, and legs, which are black. The body is marked only by four rows of minute black tubercles, each of which bears a short hair. All the excreta are deposited in a mass in the nest, and when the larvæ are fully grown, which is usually late in June, they burrow into the mass and there transform into pupæ, emerging two weeks later as moths. There is but a single brood each year.

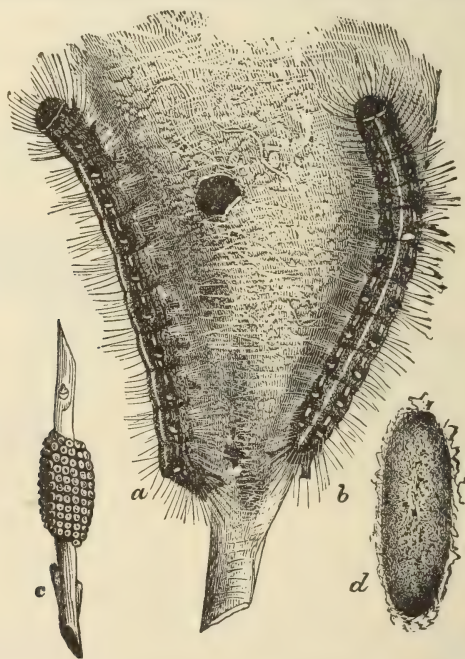


FIG. 11—Tent Caterpillar. *a-b*, larvæ; *c*, eggs; *d*, cocoon.

Remedies.—As the caterpillars congregate in their nests, it is only necessary to remove these and burn them.

Washington Notes.—Very common in the eastern part of the state, but doing very little injury except to choke-cherries. Notwithstanding the protection of their nests, many of the caterpillars are destroyed by the ichneumon parasite, *Macrocentrus nuperus*, *Cr.*, of which we have reared large numbers.

NO. 4.—TENT CATERpillARS. (*Clisiocampa erosa*) and (*Clisiocampa pluvialis*).

Diagnosis.—In spring and early summer large numbers of elongate yellowish caterpillars, usually congregated in silken nests or “tents” on various trees and shrubs.

Clisiocampa erosa feeds on the foliage of the apple, willow, poplar, prune, cherry, and alder; *C. pluvialis* feeds on that of alder in Western Washington and on wild rose and choke-cherry in Eastern Washington. It is also recorded by Dyar as feeding on apple.

Description and Life History.—The caterpillars of the two species are very similar. They may be distinguished from the following descriptions:

C. erosa.—Body black, with a row of round whitish or pale



FIG. 12.—Tent Caterpillar. Adult moth.

orange spots along the center line of the back; a broad blue band on each side of the body bordered along each side with narrow black lines; between the blue band and the dorsal row of spots an orange-red line; below the blue band an orange line. Below this and on the under side of the body, the general color is a dark bluish-gray. Hair thin and short, pale yellowish, with some reddish ones intermixed.

C. pluvialis.—Dorsal row composed of nine narrowly oval blue spots, each bordered with black; on each side of the dorsal line is a broad band of orange; on the middle of each side is a rather narrow line of pale orange, here and there broken by narrow cross lines of black; between this and the broad band of orange is a heavy black band containing two small blue dots to each segment. Below the body is black with irregular mottlings of white and yellow. Hair thin, reddish.

When fully grown, which is usually the middle of June, the caterpillars construct white, silken cocoons, in which they change

to pupae. Two weeks later the moths emerge therefrom. The adult female is a pale, yellowish moth, spreading one and one-half inches. Across the front wings extend two wavy oblique lines of brownish color. A single line crosses the somewhat darker under-wings.

The male is much smaller, spreading only an inch, and much darker in color. Figures 11 and 12, represent a closely related Eastern species.

Shortly after the moths emerge, the eggs are laid in large masses and covered with a foamy looking, gelatinous substance, which soon hardens. This serves as a protection to the eggs and also forms the first food of the young larvae. In confinement *pluvialis* lays eggs two days after emerging from the pupae. The eggs do not hatch until the following spring, so there is but one brood a year.

Remedies.—Owing to the gregarious habits of the caterpillars when young, they can easily be destroyed either by cutting off the branch with the “tent” and killing them or by using a torch and burning them, nest and all. If the latter method is used it should preferably be done in the early morning or the evening as the caterpillars are prone to wander during the day.

Searching for and destroying the egg masses in winter is also a useful means of holding the pest in check.

Washington Notes.—Both of these species occur in Western Washington, but only the latter in Eastern Washington. *C. erosa* is much the more destructive species, and at times completely defoliates orchard trees. We have reared large number of a Tachina fly (species undetermined) from *C. pluvialis* and Washburn also records rearing them from *C. erosa*. Undoubtedly great numbers of the caterpillars are destroyed by these friendly parasites.

NO. 5—THE FALL WEB-WORM (*Hyphantria cunea*).

Diagnosis.—Caterpillars an inch long, yellowish or brownish, sparsely covered with long yellowish or brownish hairs; building large silken webs usually near the tips of branches, in which they, for the most of their lives, feed; attacking apple, plum, pear, cherry, willow, cottonwood, thorn and many other trees in the fall of the year.

Description and Life History.—These caterpillars appear only in late summer and fall, and owing to their web-weaving habits can be confused with no other insects. When fully grown they leave the webs and scatter over the trees. Before pupating, they crawl into the crevices of bark and similar situations, or beneath the surface of the ground, and there build a thin brownish cocoon of silk and of their own hair. In this cocoon they transform, passing the winter in the pupal condition. From these the adult milk-white moths, spreading a little over an inch, emerge in May or June of the following year. According to Saunders the eggs are deposited in broad patches on the under sides of leaves near the tips of branches in May or June. There is but one brood a year.

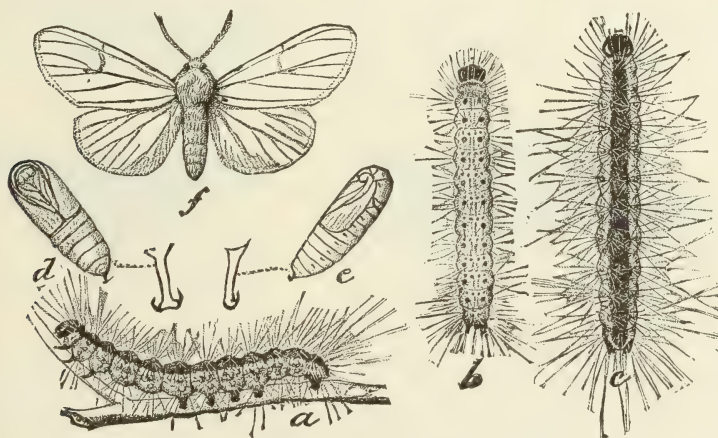


FIG. 13—Fall Web-Worm. *a*, dark larva from side; *c*, same from above; *b*, light larva from above; *d*, pupa, under side; *e*, pupa, side view; *f*, adult, all slightly enlarged.

Remedies.—The silken webs render the presence of this insect so conspicuous that it is at once detected. The webs should be removed early and the caterpillars destroyed.

Washington Notes.—Common in nearly every part of the state. East of the Cascades their native food plants seem to be cottonwood and thorn principally.

NO. 6—RED-HUMPED CATERPILLAR. (*Oedemasia concinna*).

Diagnosis.—Feeding on leaves of apple, maple, horse-chestnut, and several other trees. Longitudinally striped caterpillars, hav-

a coral-red head, and a prominent hump of the same color on the back of the fourth segment.

Description and Life History.—The caterpillars (Fig. 14) when fully grown measure an inch and a half in length. Extending the whole length of the body are numerous fine lines. On the side they are alternately black, white and yellow. The dorsal surface has five longitudinal nearly black lines, and between them broader lines of yellow. Extending the whole length on the back is a double row of tubercles, those on the hump being largest, each bearing a stout hair. On the sides are similar smaller tubercles. The humped segment is the largest, the body tapering both ways therefrom.

The caterpillars feed in flocks and are very voracious, defoliating a small tree in a few days. When disturbed they have the peculiar habit of discharging a liquid having the odor of acetic acid.

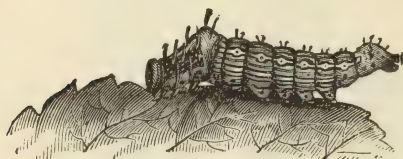


FIG. 14—Red Humped Caterpillar.



FIG. 15—Parent Moth of Red Humped Caterpillar.

There is but one brood a year, the caterpillar appearing here at the Experiment Station in August, becoming fully grown in September. They then burrow just beneath the surface of the ground and construct a tough cocoon in which the larvæ passes the winter, not changing into pupæ until the following spring. The adult is an inconspicuous moth, shown in Fig. 15.

It emerges from the pupa in July.

NO. 7.—THE BUD MOTH (*Tmetocera ocellana*).

Diagnosis.—Infesting the apple; very small pale brown caterpillars, feeding on the opening or half-opened buds, both of leaves and flowers; frequently several buds may be tied together by silken threads, and in a short time the partly eaten leaves turn brownish, making the work of the pest very conspicuous.

Description and Life History.—The adult (Fig. 16) is a small moth spreading about three-fifths of an inch. Its general color is

dull ashy gray; across the middle of the fore wings is a broad band of whitish color, and near the hind angles is a small eye-like spot. They appear in June and early July, and deposit their eggs singly on the under sides of the leaves. In a short time these hatch into larvæ, which begin to feed on the under side of the leaf near the midrib. A few hours after birth the larva constructs a silken tube, open at both ends, into which it retreats for

shelter when disturbed. This tube is usually placed along the midrib, and from time to time is lengthened by the larva, rarely attaining a length of one inch. The larva feeds on the pulp and lower epidermis of the leaf in a more or less irregular area on each side of the midrib. The whole of the feeding ground is covered with a very thin web, under which the larva works. In August the larvæ leave their tubes and retreat to the twigs, constructing little cocoons in the crevices of the bark, usually near the buds. The cocoons are only one-eighth of an inch long and are very inconspicuous, as they are covered with particles of dirt and bark, so as to be scarcely distinguished from the bark.

With the first days of spring the larvæ leave their cocoons and begin their work of destruction on

the buds. Frequently they entirely destroy the buds by eating out the central portion. In some cases they even burrow one or more inches into the pith of the young twigs. When thus attacked, the twigs die back as far as the burrow.

Some of the larvæ do not leave their winter cocoons until the buds are half opened. These roll the leaves into tubes in which they live most of the time, coming forth only to feed. In feeding they draw the leaves together, tying them with silken threads,

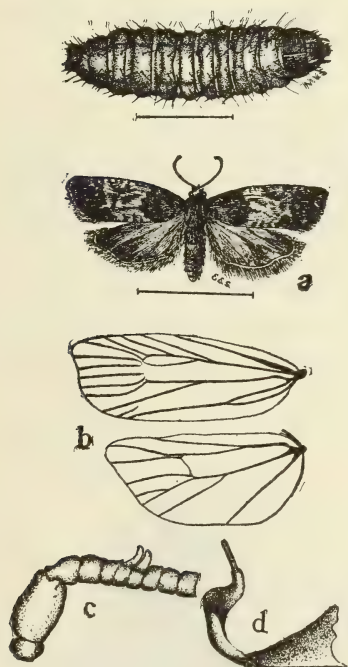


FIG. 16.—Bud Moth: a, imago, twice natural size; b, wings, showing veining; upper figure, the larva, about three times natural size.

thus forming rude nests. Many of the half eaten leaves die and turn brown, rendering the nests very conspicuous.

In June the larvæ form silken cocoons in their tubes, and transform therein into pupae, from which the moths emerge later.

Remedies.—Slingerland, from whom the above account is taken, recommends that the trees be sprayed with Paris Green as soon as the buds begin to open, followed by a second application a week or ten days later. Later spraying may also be advisable, but the trees should never be treated when in bloom.

Washington Notes.—This insect was introduced in 1893 at Genesee, Idaho, only a few miles from the Washington line. It came on nursery stock from Rochester, N. Y., so that it is not at all unlikely that it has also been brought into this state, although it has not yet been so recorded. It should be looked for, however, and if found vigorously combatted.

NO. 8—THE APPLE TINGIS (*Corythuca arcuata*).

Diagnosis.—Minute blackish gauze-winged insects, congregated in large numbers on the underside of the leaves of apple and hawthorn.

Description and Life History.—The adults (Fig 17) measure scarcely one-eighth of an inch in length. Their wings are beautifully veined, looking much like lace, nearly transparent, excepting a smoky tinged blotch on the outer anterior angles, a transverse band of the same near the tips, and a more or less distinct longitudinal band of the same color along the inner margin. On each side of the head is a broad, leaf-like expansion of the same structure as the wings. All stages of the insect may sometimes be found on the same leaf, and they are quite sluggish in their movements.



FIG. 17.—Apple Tingis, greatly enlarged.

The eggs are curiously shaped and are fastened to the leaves and covered by a shellac-like substance. The larvæ and active pupæ resemble the adult in shape, but are wingless. When

abundant, this insect weakens the plant in the same way as aphides, that is, by puncturing the leaves with their sharp beaks and sucking juices therefrom. There are probably several broods a year, but they are most common in August.

Remedies.—Spray with kerosene emulsion, using an underspray nozzle.

Washington Notes.—Common in Western Washington, where it seems to be an introduced insect. While the damage it does is rarely serious, specimens are frequently sent to this station for identification.

NO. 9.—THE PEAR OR CHERRY SLUG. (*Eriocampa cerasi*).

Diagnosis.—Attacking the leaves of the pear, cherry, and quince. Slug-like larvæ, a half inch long, olive-brown in color, covered with a slimy substance.

Description and Life History.—The adult is a small four-winged saw-fly nearly one-fourth of an inch long, and spreading about twice that much. The body is shiny black, the wings transparent with smoky shadings. All of the saw-flies are provided with peculiar saw-like organs, at the posterior end of the body, by which the incisions are made in plants, in which the eggs are

laid. The first brood of saw-flies appears just before the cherries are ripe, and the eggs are laid singly in little slits cut in the leaves. Shortly after the cherries are ripe the larvæ or slugs may be found in abundance on the leaves, of which they consume only the pulp,



FIG. 18.—Pear and cherry slug, fly and larvæ.

causing these portions of the leaf to turn brown. When fully grown the slugs crawl or fall to the ground, into which they burrow to a depth of two or three inches, where they form an oval earthen case, glued together and lined by a sticky, glairy slime. In these cases the larvæ become pupæ, and in about four weeks the adult flies emerge therefrom. These deposit eggs for the second brood of larvæ which appears in August. This second brood passes the winter as pupæ in the ground. (Fig. 18).

Remedies.—Spray with Paris Green as soon as the slugs appear. In the case of cherry trees this is not always desirable, and powdered hellebore in the proportion of one pound to thirty gallons of water may be used instead.

Where the slugs are not abundant, air-slaked lime or even road dust will destroy many of them if dusted liberally on the foliage.

Washington Notes.—Abundant in most parts of the state, having been long introduced. It does serious damage at times, when not promptly destroyed.

NO. 10.—THE PEAR-LEAF BLISTER MITE. (*Phytoptus pyri*.)

Diagnosis.—Bright red pimple-like spots on young developing pear leaves, most conspicuous on the upper side. Late in the season the pimple-like galls are brownish in color, forming corky thickenings on the under sides of the leaves.

Description and Life History.—The adult (Fig. 19) is a minute four-legged mite measuring one hundred and fiftieth (1-150) of an inch in length, being scarcely visible to the naked eye. Its body is cylindrical in form and marked crosswise by numerous fine striæ. As soon as the leaves burst from the buds in spring the mites burrow into them forming the bright red galls (Fig. 20) which are hollow, and have a minute opening on the under side of the leaf. In these galls eggs are laid which soon hatch into young mites. As fast as new leaves are brought forth, other mites migrate to them, forming new galls, and this process continues as long as leaves are developed. Before the leaves fall in autumn the mites crawl back to the twigs and pass the winter in cracks in the bark and similar places, but more particularly beneath the scales of the terminal buds. At no stage of the mite's life is it able to move fast, but the pest becomes spread from tree to tree by crawling on insects, the feet of birds, and probably in other similar ways. The damage done is sometimes quite severe, as the function of the leaves is seriously impaired by the attacks of the mite. The diseased leaves also fall prematurely. (Fig. 21).



FIG. 19.—Adult Pear Leaf Blister-Mite. Greatly magnified.

Remedies.—It is entirely useless to attempt to destroy this mite during the summer, as it is then protected in its gall in the leaf, so that anything that would destroy it, would destroy or seriously injure the leaf also. It may be easily destroyed in winter by spraying with strong kerosene emulsion. The oil penetrates the crevices in the bark and between the scales, killing all the mites. For this purpose *dilute the the kerosene emulsion with only three times its quantity of water.*

Washington Notes.—This pest has become very common in the state, especially the Eastern part, in the last three years and seems to be spreading rapidly. We especially caution fruit-growers that this pest is one that remains in an orchard when once introduced if not vigorously combatted. Climatic conditions may in some



FIG. 20.—Pear-leaf Blister-mite. Section of a gall in spring. At *n* the structure of the leaf is normal; *o*, the opening into the gall; *e*, eggs.

years kill off large numbers of them, but this is too uncertain a factor to depend upon.

We have found that kerosene emulsion diluted five times, as recommended by Slingerland, does not destroy the mites here.

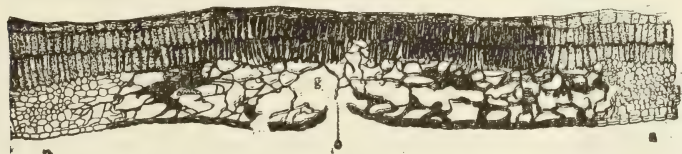


FIG. 21.—Pear-Leaf Blister-Mite: section of leaf showing structure of gall in autumn; *n*, normal structure of leaf; *g*, gall; *o*, opening of gall.

NO. 11.—THE CINNAMON TUSOCK-MOTH. (*Orgyia badia*.)

Diagnosis. Attacking the elm, rose, currant, locust, cypress, willow, and many other ornamental trees and shrubs; long haired caterpillars, measuring about one inch, easily recognized by the two long black pencils of hair on the front end of the body, and a single similar pencil on the hind end.

Description and Life History.—In late fall or winter numerous cocoons may be found under the eaves of buildings, on the twigs of trees, and in other sheltered situations. Many of these will be

completely covered on the outside with a single layer of pale wood-colored spherical eggs, each of which has a brownish pit near the center. Other cocoons will have no eggs on them, and all of the cocoons are empty, or contain only the pupae of parasites. These are the cocoons of the Tussock-moth. Early in summer the eggs hatch into larvæ which at once crawl on to the leaves and begin to devour them. They become fully grown in August. At this time they are an inch or more long. Besides the pencils of hair already mentioned, there are four brush-like tufts of brownish hair, the first on the fifth segment of the body, and one each on the three following segments. The remaining hair of the body is black and yellow intermixed. The larvæ (Fig. 24) become fully grown late in August or in September, and crawling to a suitable place construct the whitish or brownish cocoons, in



FIG. 22. — Tussock Moth, adult male.



FIG. 23.—Tussock Moth: *a*, female moth; *b*, young larva; *c*, female pupa; *d*, male pupa.

which they change to pupae. A short time afterwards the adults emerge. The male (Fig. 22) expands one inch, and is of a dark cinnamon color. The fore wings are rather darker than the hind wings, and are crossed near the middle by a broad paler band. At the posterior outer angle is a small bean-shaped white spot. The hind wings are unmarked.

The female is a very different creature, (Fig. 23 *a*) never attaining but the merest rudiments of wings; her body is dull gray in color, and oval in form. After emerging from the pupa she crawls on the cocoon and awaits the attendance of the male, after which she lays the eggs on top of the cocoon. As the eggs are laid, she gradually decreases in size, and when her work is accomplished falls to the ground and dies. So far as our observations go there seems to be but a single brood each year.

Remedies.—Like other caterpillars, this species may be very

abundant one year, and very rare the next. When abundant spray with arsenites.

In winter all the cocoons covered with eggs should be gathered and burned. The other cocoons should be left, as they contain either empty pupal skins, or else the pupae of parasites which destroy the caterpillars.

Washington Notes.—Not found in the state except west of the Cascade mountains. We have reared from the eggs a minute parasite (*Lampronota sp.*), and from the pupae the ichneumon fly, *Pimpla pterelas*, Say. These parasites do much to keep down the numbers of the Tussock-moth.

NO. 12—CUTWORMS.

Larvæ of Noctuid Moths of Many Species.

Diagnosis.—Earthy colored larvæ differently marked in the various species, from one inch to two inches long. Cutting off tender plants near the surface of the ground, or eating the leaves; some species also climb trees and devour the foliage; feeding only at night, burrowing into the ground during the day.

Description and Life History.—The cutworms are all larvæ of the various species of Owlet moths (family *Noctuidæ*), which in their habits are all very similar. Nearly all of them are protectively colored to resemble the soil. The adult moths fly mainly at night, and the eggs are deposited on the various food plants, soon after these hatch into larvæ. The larvæ feed only at night, concealing themselves under sticks or stones, or burrowing in the ground in the daytime. Most of them eat only low-growing plants, but the very common dark-sided cutworm (*Carneades messoria*) climbs up the trunks of trees. When fully grown the larvæ construct earthen cocoons two or three inches beneath the surface of the ground, and change therein to mahogany colored pupæ. Some time later the adult moth emerges therefrom. Many of the species produce two broods each year.

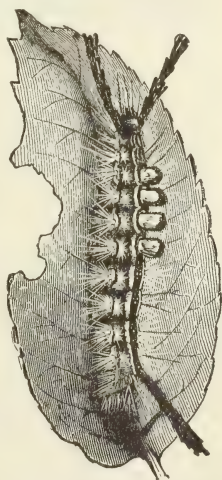


FIG. 24.—Fully grown larva of Tussock Moth.

Remedies.—If the worms are attacking young plants, such as cabbage and tomato, the best method is to find the worms and destroy them. This method is very effective and one person can go over a large field in a day. Where indications are found of the insects work, the worm is sure to be found in the soil near the root of the plant attacked.

For climbing cutworms, or when they are attacking well-grown plants, spray with Paris Green. Sometimes it is desirable to destroy cutworms in the ground before setting out a crop. This can be done by tying clover or other succulent green plants into

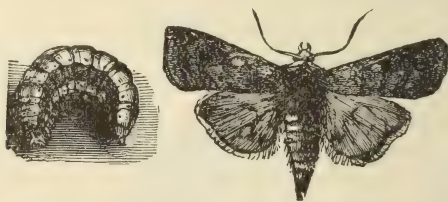


FIG. 25.—Dark-sided Cut-worm : larva and inago.

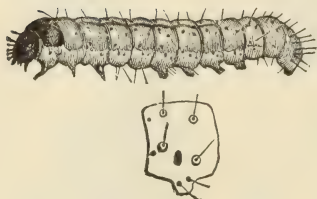


FIG. 26.—Glassy Cut-worm larva, natural size, and one segment enlarged to show arrangement of naric



FIG. 27.—Parent Moth of the Glassy Cut-worm.

tight balls. These balls are then soaked in Paris Green water, (use one ounce to ten gallons water) and the poisoned baits scattered over the field. The baits will keep fresh longer if covered with a light board. The cutworms find the baits and feeding upon them are destroyed, but as the poison acts slowly it is only rarely that dead worms are found about the baits.

The use of tin cylinders (tomato cans with the ends taken out are excellent) is sometimes resorted to to protect young plants.

Washington Notes.—Two of our most troublesome cut worms are *Corneades messoria* (Fig. 25) and *Hadena devastatrix* (Figs. 26 and 27).

NO. 13.—THE FLATHEADED APPLE TREE BORER. (*Chrysobothris femorata*.)

Diagnosis.—Discolored spots on the bark of the trunk, from a hole in which sawdust-like particles frequently protrude. Examination usually discloses a whitish grub beneath. Trees with cracked or injured bark, or sickly trees are most liable to attack. In midsummer the very active adult beetle may be seen on the sunny side of the trunks.

Description and Life History. The adult (Fig. 27½) is an oval beetle about one-half an inch long, of a shining bronze color; the underside looking like burnished copper. The eggs are laid in midsummer and soon hatch into small larvæ which burrow through the bark into the trunk, cutting out broad flattish tunnels. Usually the borings of this species is confined to the sap wood, on the juice of which the larva lives. Rarely a single borer will completely girdle a tree, which in such a case of course dies. The peculiar shape and broad flat head of this borer (Fig. 27, a) at once distinguish it. Before changing into a pupa the larva burrows out partly through the bark; about three weeks later it emerges as a perfect beetle. From the laying of the egg to the emerging of the adult occupies just a year.

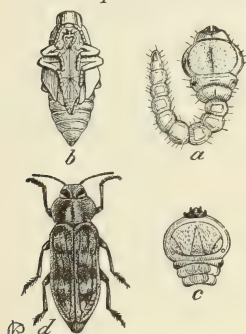


FIG. 27½—Flat Headed Borer
a, larva; b, pupa; c, front
of larva; d, beetle.

Remedies.—The best remedy is to prevent the beetles from laying their eggs on the tree: This can be done by keeping the trunk covered with some soap solution during June and July. An excellent solution for the purpose is made by adding one part crude carbolic acid to twelve or fifteen parts soft soap. This can be applied to the trunk and larger branches with a broom or white-wash brush. Two applications are necessary, one early in June and the second a month later. Especial care should be taken to protect the base of the trunk. In the fall the trees should be carefully examined for the borers. Their presence is disclosed by the discolored spot and sawdust like castings. When found they can be easily cut out with a sharp knife and destroyed.

Washington Notes.—Found throughout the state, but apparently not very abundant as yet. It is probable that a great deal of the damage ascribed to this insect is done by the nearly related beetle, *Dicerca divaricata*. Attacks also the plum, pear and cherry, and rarely the peach, besides various other trees.

NO. 14.—THE SNOWY TREE CRICKET. (*Oecanthus niveus*.)

Diagnosis.—Rows of punctures in the stems of raspberries, grapes, and many other shrubs; in the bottom of each puncture in the pith is a long narrow egg. Where the stem was punctured the previous year, there is usually a split on one side, from one to several inches in length.

Description and Life History.—The adult male (Fig. 28) of the Snowy Tree Cricket is somewhat less than an inch long, with pale



FIG. 28.—Snowy Tree Cricket; male.



FIG. 29.—Snowy Tree Cricket; female.

greenish-white, nearly transparent, flat wings. The female (Fig. 29) is similar in size and color but with much narrower wings, bent down at the sides; she is also provided with a sharp ovipositor by which the punctures are made in the twigs, and through which the eggs are laid. The eggs are laid late in fall and hatch early in the following summer. When young, the crickets are very active, and run about over the plants, feeding on plant lice, and they are even said to devour each other. After they have attained their full growth they feed on the tender shoots of various shrubs, and sometimes do small damage in this way. The eggs (Fig. 30) are laid in the pith of the stems of raspberries, grapes, roses, apples, peaches, plums, elder, willow, poplar, and many other trees and shrubs; indeed it is doubtful if any trees are immune from attack, the only requisite being a twig provided with pith. However, shrubs in which the wood is thin and the pith abund-

ant, such as roses, raspberries, grapes, elder and willow, are much preferred by the insect. The eggs have also been recorded from various herbs, such as goldenrod, sunflower, etc. The principal damage consists in weakening the stem, so that it breaks on the slightest provocation, but the good that the insect does in the young state, by destroying plant lice, nearly compensates for the damage it does later.

Remedies.—The only remedy is to cut out the attacked canes or twigs and burn them, so as to destroy the eggs. It is doubtful if this is of much efficacy if there is native shrubbery, as the insect breeds equally well in various shrubs; still it is the only way to reduce their numbers at all.

Washington Notes.—Abundant in the warmer valleys of Eastern Washington, such as Yakima, Snake River, and Walla Walla. Much rarer in Western Washington. The adults are very abundant in July, August and September, but are not often seen, owing to the way they conceal themselves, and to their protective coloration.

The males are musical, and throughout the warm summer nights their rather pleasant chirping notes may be heard.

NO. 15.—THE CURRANT BORER. (*Sesia tipuliformis*).

Diagnosis.—Infesting the currant and more rarely the gooseberry. Whitish grub like larvæ burrowing channels in the pith of the stem, causing the foliage to look unhealthy and the fruit to be smaller in size; sometimes the stems die.

Description and Life History.—This destructive larva is the young of the wasp-like moth shown in Fig. 31. Like so many others of our injurious insects it has been imported from Europe. The moths first appear late in June and may then be seen rapidly flitting

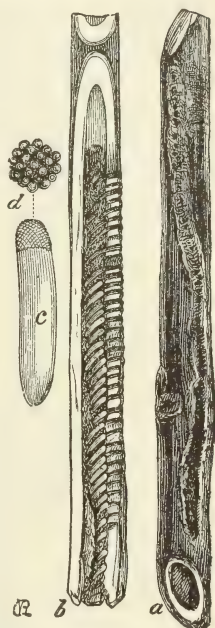


FIG. 30.—Snowy Tree Cricket: *a*, raspberry cane showing egg punctures; *b*, section through same; *c* and *d*, magnified view of egg.



FIG. 31.—Currant Borer, adult moth, natural size.

about the currant bushes in the bright sunshine. They measure about three fourths of an inch in length, and spread about the same. The body is bluish in color, with three golden bands near the middle. Excepting the brownish-black tips, the wings are quite transparent.

The eggs are laid singly near the buds, and in a few days hatch into minute larvæ which at once eat their way to the pith, and then bore up and down in the stem for several inches, enlarging the channel as they grow older. When fully developed the larva (Fig. 32 *b*.) is a soft whitish grub, with a darker line along the back, the head and legs being brown. The larva changes into a pupa (Fig. 32, *a*) in its nest, before doing which, however, it eats a passage nearly through the stem, leaving only a thin covering of bark. When the pupa is ready to transform, it wriggles its way into this passage, bursting the thin covering, and then partially protrudes itself out of the opening. A split then appears down its back through which the adult moth escapes. There seems to be but one brood a year.

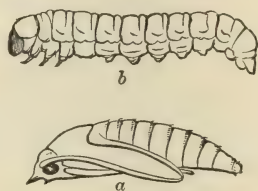


FIG. 32.—Currant Borer, *b*, larva; *a*, pupa, both much enlarged.

Remedies.—The only way to fight this insect profitably is to cut out and burn the infested canes. This should be done in spring or fall.

Washington Notes.—Quite abundant in the western part of the state, where it is the most serious enemy of the currant.

NO. 16.—THE YELLOW WOOLLY-BEAR. (*Spilosoma Virginica*).

Diagnosis.—Yellowish, long-haired caterpillars, one and one-half inches long, feeding on various plants, among them, apple, rose, currant, asparagus; indeed there are few plants that it will not feed upon.

Description and Life History.—The adult (Fig. 33 *c*) is a moth, spreading about one and three-fourths inches, nearly pure white in color. The exceptions to this color are two small black spots, one in the center of each fore wing; and three similar spots on each hind wing. Occasionally the spots are nearly or entirely obliterated. The abdomen is marked by three rows of black dots, one on the

top, and one on each side. Between the dots on the sides are broad orange splotches.

The eggs are deposited in clusters on the leaves of the insect's various food plants, and in a few days hatch into larvæ. These at first are gregarious, but soon separate, so that half or fully grown larvæ are usually alone. The full grown caterpillars (Fig. 33 *a*) measure one and one-half inches in length. Their color varies from nearly white to dark brown. There are two broods each year, the second brood of caterpillars, which appear in September and October, being very much more numerous than the first.

When fully grown the larva constructs a brownish cocoon of its own hair, and changes therein to a pupa, (Fig. 33 *b*) and in this condition passes the winter. The adults emerge in May, and become the parents of the first brood of larvæ.

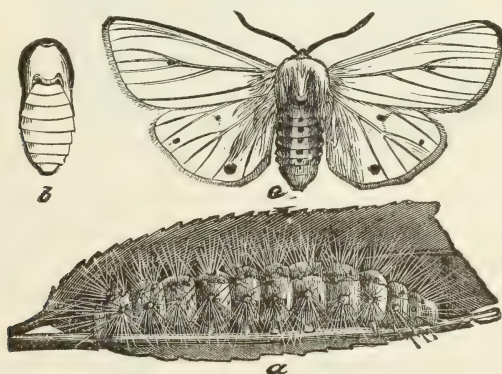


FIG. 33—Yellow Woolly Bear. *a*, larva; *b*, pupa; *c*, female moth.

Remedies.—Ordinarily the insect is not so abundant but that it can easily be controlled by gathering the larvæ and destroying them. This is best done when they are young. If very abundant, spray with Paris Green or London Purple.

Washington Notes.—Found throughout the state, it being a native, but much the more abundant west of the Cascades.

NO. 17.—SAN JOSE SCALE. (*Aspidiotus perniciosus*).

Diagnosis.—Attacking the apple, pear, peach, plum, cherry, and perhaps all *deciduous* shrubs or trees. Minute circular scales, smaller than a pin head, causing bright red ring-like spots on the fruit of apple, pear, peach, and plum. *No other scale insect does*

this. When numerous they completely cover the branches and twigs, giving them a characteristic whitish mealy appearance. Upon scraping such a twig with the finger-nail, a yellowish oily fluid will be seen, which comes from the crushed bodies of the scales. Cutting a strip of the bark on badly infested trees will disclose a brownish discoloration which may also extend to the wood.

Description and Life History. The San Jose scale is at once distinguished from other pests of this family by the small size of the scales, which measure commonly about one sixteenth of an inch in diameter, though rarely specimens may be found nearly an eighth of an inch across. The scales (Fig. 34) are circular, somewhat elevated in the middle, which bears a small black or yellowish pointed process. In badly infested orchards they completely cover the trees, (Fig. 35) giving the branches an unhealthy, grayish, scurfy appearance.

In winter the scales are to be found only in a half or nearly full-grown condition, and completely dormant. With the first flow of sap in spring they begin to feed again, and become fully grown in May and June, when the first brood of larvæ is produced. As far as known all these larvæ (Fig. 36) are born alive. They move about actively for a few hours or even a day or more, finally settling on tender twigs, leaves, or fruit, into which they gradually insert their beaks and begin to absorb juices from the plant.

From this time on, broods are produced incessantly through the summer, and the insect can be found in all stages until the leaves fall in October. Shortly after settling on a spot, the larvæ secrete a waxy substance, the beginning of the formation of a scale.

“In two days the insect becomes invisible, being covered by a pale grayish-yellow shield, with a projecting nipple at the center. This nipple is at first white in color. Twelve days after hatching the first skin is cast. The males at this time are rather larger than the females, which have large purple eyes, while the females have lost their eyes entirely. The legs and antennae have disappeared in both cases. Six days later the males begin to change to pupae, while the females have not yet cast their second skin. At this time the females are so tightly cemented to the

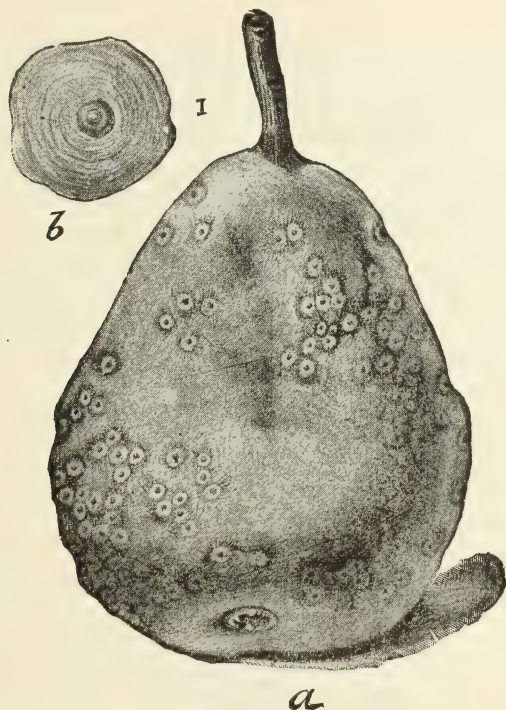


FIG. 34—San Jose Scale. *a*, California Pear, moderately infested—natural size; *b*, female scale, enlarged.



Fig. 35—San Jose Scale. Apple branch with scales *in situ*—natural size; enlarged scales above at left.

scale that they can not be removed without crushing. In two or three days more, or twenty to twenty-one days after hatching, the females cast their second skin, which splits around the margin of the body. At twenty-four days the males begin to issue, emerging from the scales as a general thing at night. At thirty days the females are fully grown and embryonic young can be seen in their bodies (Fig. 37); and at from thirty-three to forty days the larvæ begin to make their appearance." [Howard.]

The adult male (Fig. 38) is a delicate two-winged creature, bearing a straight stoutish appendage at the posterior end. It lives in this adult condition but a short time.

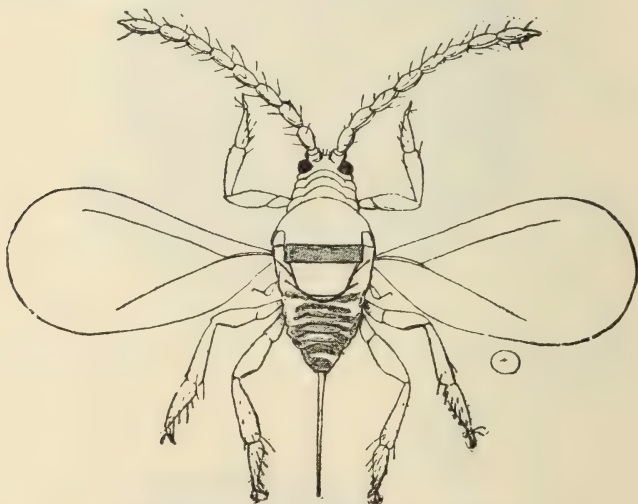


Fig. 38—San Jose Scale. Male, greatly enlarged.

The female never attains wings or leaves the scale, after it is once formed.

Only in the active larval condition can the pest become spread. This is greatly facilitated by the habit of the larvæ of crawling on other insects or on the feet of birds, and being thus carried from tree to tree.

Remedies.—The remedy universally used on the Pacific Coast is the sulphur, lime and salt solution, to be applied as a winter-spray. In California and in this state, judging from the testimony of numerous orchardists, this solution has proven to be a perfect remedy. In one orchard that has come under our observation the

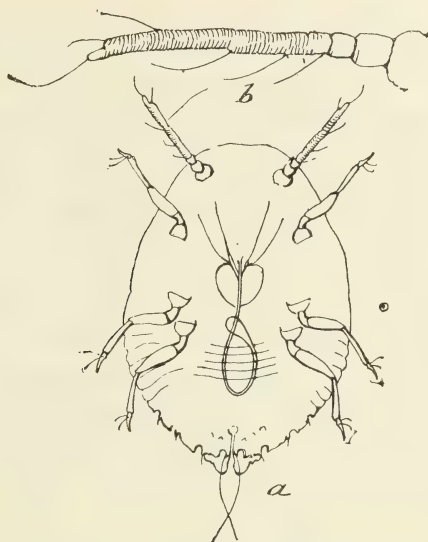


Fig. 36—San Jose Scale. *a*, young larva, greatly enlarged; *b*, antennæ of same, still more enlarged.

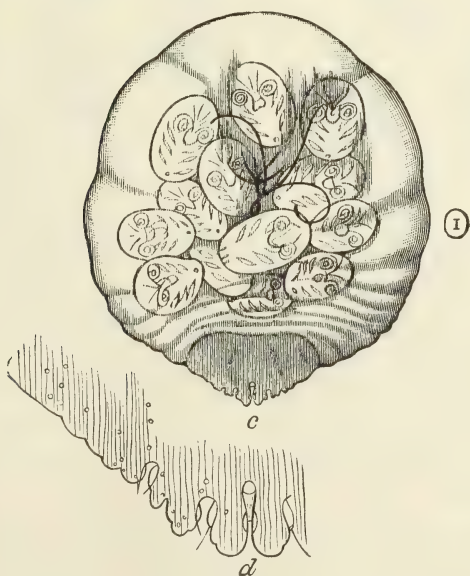


Fig. 37—San Jose Scale. *c*, adult female containing young, greatly enlarged; *d*, anal fringe of same still more enlarged.

scale has been entirely extirpated by this remedy. In another orchard we found a very different state of affairs, which may however not have been the fault of the spray.

Mr. L. O. Howard has found the sulphur, lime and salt spray entirely eneffective against the San Jose scale in the East. The only completely effective solutions there were found to be whale-oil soap—whale-oil soap two pounds, water one gallon—and the resin solution in six times its ordinary strength. Both of these are expensive, the latter the more so. For the present we advise the use of the sulphur, lime and salt, and we especially desire to hear the experience of orchardists with this substance.

Washington Notes.—Introduced in this state for at least ten year. Quite generally distributed in Eastern Washington, especially in the older orchards. Reported in Western Washington only from Vancouver (C. A. Tonneson.)

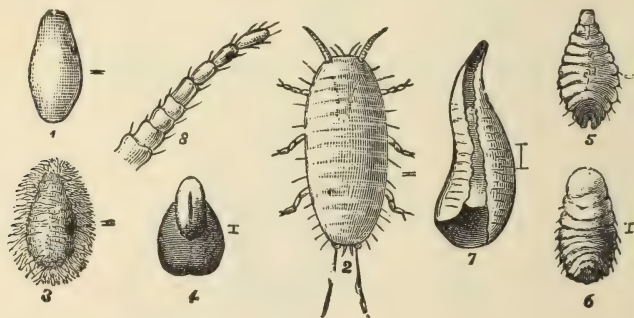


FIG. 51.—Oyster Shell Bark Louse. 1, egg; 2, larva just hatched; 3, larva when forming scale; 4, scale after second plate is formed; 5, 6, forms of louse taken from scale; 7 fully formed scale, all greatly enlarged.

NO. 18.—THE OYSTER-SHELL SCALE. (*Mytilaspis pomorum.*)

Diagnosis.—Infecting the trunk, branches and especially the twigs of the apple and pear. Small scale-like insects, shaped somewhat similar to an oyster shell. Apparently lifeless, and sometimes crowded so closely together that the bark beneath them cannot be seen.

Description and Life History.—Like all scale insects, this species sucks the juices of the tree through a sharp beak, which it inserts into the tender twigs, and having once located on a spot, remains there through its life. Under most of the scales which are females

will be found in early spring from twenty to fifty or more minute eggs. These hatch in May and June into very small yellowish larvæ which run actively over the tree. Most of them soon locate themselves near the tips of the twigs, insert their beaks and begin to suck sap. A waxy substance exudes from their skin, and as the insects become mature this secretion gradually becomes formed into a leathery scale, which serves as protection. Late in summer the female scales lay their eggs, after which they perish. At this time these scales will be found to contain nothing but masses of eggs, which remain in this condition over winter, hatching early the next season.

The male scales are much less common than the female. In July the males acquire wings and for a short time fly about, dying after mating with the females. The latter are wingless throughout their lives.

The insects spread from tree to tree in the active larval stage, which lasts but a few days. Undoubtedly many are carried from tree to tree by clinging to other insects, spiders, and the feet of birds. (Figs. 51 and 52).

Remedies.—In fall or winter scrape as many of the scales from the bark as possible. If only a few trees are affected, use a wash made by dissolving two pounds of whale oil soap in one gallon of water. Kerosene emulsion diluted with only one part water, or resin soap (winter formula) will destroy most of the scales.

The above remedies are to be used only when the trees are dormant.

In May and June, when the young scales are unprotected, great numbers of them can be destroyed by spraying with kerosene emulsion, ordinary strength.

Washington Notes.—This insect has been introduced in the state for several years, and in some orchards has done serious injury, notably in Western Washington. While rather difficult to exterminate in the first place, no pains should be spared in doing this, as an orchard free from it is in very little danger of again becoming infested, unless there are scales in immediately adjoining orchards.



FIG. 52.—Pieces of bark covered with Oyster-shell Bark-louse.

NO. 19.—THE PEPPER-AND-SALT CURRANT MOTH.
(*Eubyia cognataria*).

Diagnosis.—Long, smooth, green or brownish caterpillars, which are “measuring worms;” when not feeding they lie close to the stems, or clinging only by the hind pair of false legs, extend their bodies at an angle from the twigs, which they very closely resemble. Feeding on currant, rose spiraea, tamerix and perhaps other plants.

Description and Life History.—The adult is a handsome moth,



FIG. 39.—Peper-and-Salt Currant Moth.

spreading nearly two inches, (Fig 39), and easily recognized by its pepper-and-salt markings. They are on the wing in June and July. The larvæ become fully grown in September, when they descend to the ground, into which they burrow for two or three inches and there transform into brownish pupa. From these the moths emerge the next year.

Remedies.—Usually not so abundant but that they may be easily controlled by hand picking. If numerous, spray with the arsenites.

Washington Notes.—Found in all parts of the state, where it is native. It is usually more partial to currants, but we have found it in abundance on rose and tamerix.

NO. 20—THE BOX-ELDER BUG. (*Leptocoris trivittus*, Say).

Diagnosis.—Dull blackish bugs a half inch long, marked with reddish lines; infesting the box-elder and fruit trees, and congregating on the sunny sides of houses, especially in spring and fall; they frequently become troublesome in houses also.

Description and Life History.—The adults may be found at all seasons of the year, but are most abundant in summer and fall. They pass the winter hibernating under fallen leaves, boards, and in similar sheltered places. In spring they betake themselves to the trees, and lay their eggs in the crevices of the bark. These soon hatch into young which closely resemble the adult excepting that they are wingless, and bright red in color. Although

immature stages may be found throughout the summer, there seems to be but a single brood each year.

The adults as well as the young possess no biting jaws, but only a sharp sucking tube, which they insert into tender twigs or leaves and suck sap. They also injure the fruit of various trees by puncturing it and sucking the juices.

In the house they are entirely harmless, except from their unpleasant habit of crawling over everything, dropping into milk pans, etc.

Remedies.—The box-elder bug is a difficult insect to deal with. Like other pests it may be very abundant one year and nearly absent the next. The box-elder tree is their natural food, so that this tree should not be planted.

Immense numbers of them may be killed, especially in spring and fall when they congregate on the sides of buildings, etc., by spraying with kerosene or strong kerosene emulsion; boiling water may be used for the same purpose, or a flat board may be used to crush them.

Washington Notes.—Abundant throughout Eastern Washington a natural result of the too common planting of the box-elder tree. Their habit of puncturing fruit seems to be indulged in only when their natural food is scarce.

APHIDIDAE OR PLANT LICE.

The life histories of all the plant lice are quite similar to each other, while on the other hand they are very different from the life histories of most other insects. The aphides themselves, although of many species, resemble each other very closely. They are minute soft-bodied insects, most species colored green like the plants they feed upon; others, however, are reddish or blackish, and some secrete from their bodies and cover themselves with a flacculent white waxy substance, which gives them a woolly or cottony appearance. All of the species obtain their food by inserting their sharp beaks into the leaves, stems or root of their host plant, and sucking juices therefrom. When feeding on the leaves, their presence may be detected by the paler color of the infested leaves, and frequently by the distortion of the foliage. Some forms secrete an irritating liquid and cause true galls to be formed on the leaves, in which they live quite well protected.

Most of the root feeding species cause galls to appear as the result of their attacks. The same species of aphid may exist in both leaf and root-infesting forms. Most of the species are provided with two short honey tubes on the back of the abdomen, which secrete a sweet sticky fluid, called honey-dew. Ants are very fond of this honey-dew, and are sure to be found in numbers on any plant infested with the aphides.

So far as known all aphides pass the winter in the condition of eggs, which are deposited on the food plant of the species. These eggs hatch in spring, and produce *wingless females only*. These females bring forth living young, entirely without the intervention of the males; this process is called *Parthenogenesis*.

Each parthenogenetic female bears from two to three young daily for a period varying from two to four weeks in the different species. The young bear progeny when about a week or ten days old, in the same manner as the mother. Some of the later generations are winged, and thus the species spreads rapidly from place to place.

The last generation in the year brought forth by the parthenogenetic female develops into perfect sexual males and females, the latter wingless. After pairing the winter eggs are laid.

The increase in numbers of all species of aphid is so rapid that the progeny of a single individual may amount in a single season to over a *trillion individuals*. For this reason early sprayings are of great importance for this class of insects.

Natural Enemies.—The soft unprotected bodies of the aphides subject them to many insect enemies. The most important of these are the 'ladybird' beetles, or coccinellidae (Fig. 1); the golden-eyed fly, *chrysopa*, (Fig. 2); and the syrphus flies.

All of these feed on the aphides, the first both in its adult and larval states, the others only in their larval conditions.

Besides these immense numbers of the plant lice are destroyed by the minute parasitic ichneumon and chalcid flies, which lay their eggs in the bodies of their victims, finally destroying them. Sometimes the aphides are held entirely in check by their enemies, but more frequently they require vigorous combatting.

Remedies.—Most species of plant lice can easily be destroyed except in the egg stage by spraying with kerosene emulsion, or the resin solution, and these substances are to be used unless

otherwise stated. With all species of *aphididae*, early sprayings are highly desirable. The first should be given as soon as the eggs are fairly hatched; and subsequent sprayings as often as necessary. The early application of the kerosene emulsion is particularly necessary in such species that form galls or cause the leaves to roll; when protected within the galls or rolled-up leaves it is almost impossible to destroy them by spraying.

NO. 21.—WOOLLY APHIS OF THE APPLE. (*Schizoneura lanigera*).

This species exists in two forms, one of which attacks the roots, the other the trunk and branches of the apple. The great majority of the individuals are wingless, but winged ones also occur especially in the later broods of the year. The insect derives its name from a peculiar white fluffy substance which exudes from their bodies, making them appear as though covered with cotton, and rendering them very conspicuous on the trees. They are especially liable to be abundant on suckers from the bases of trees

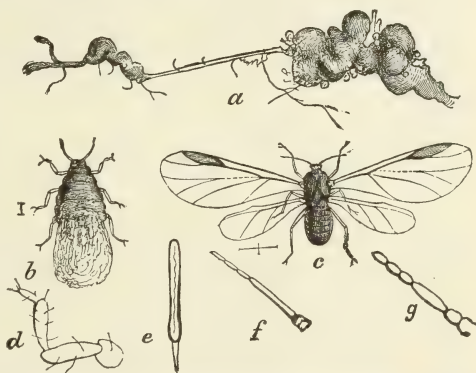


FIG. 40.—Woolly Aphis; *a*, galls on rootlets; *b*, wingless louse; *c*, winged louse; *d*, leg; *e*, beak; *f*, antenna. All enlarged except *a*.

and in the forks of the branches. The cottony covering serves to some extent as a protection, so that this species is rather more difficult to kill than other aphides. (Fig. 40).

The root form is the more injurious, and by its attacks, peculiar corky galls are formed on the roots, in the crevices of which the lice may be found. These galls not only interfere seriously with the functions of the roots, but also form centers of decay, and may cause the death of the tree.

The branch form weakens the tree by feeding on the sap, and not infrequently causes the bark to split in places as the result of its attacks; it never forms true galls like the root form. The entire life of the woolly aphis is spent on the apple, the winter eggs being laid in sheltered crevices.

It must be understood that the two *forms* differ mainly in their mode of life. The presence of either form will sooner or later give rise to the other, and badly infested trees are sure to be attacked both on the roots and on the branches.

Special Remedies.—This pest is far more likely to be introduced on nursery stock than in any other way. The roots of purchased apple trees should always be examined for the galls of this insect; if the galls are large or numerous, *reject the trees*. If they are small and few, they may be completely disinfected by dipping the roots in kerosene emulsion or in hot water (120° – 140° Fahr.) for a moment. If trees in the orchard are attacked by the root form, the soil should be removed as much as possible from them and the roots thoroughly treated with kerosene emulsion or with water heated nearly to the boiling point.

Bisulphide of carbon may also be used with success for this form of the insect.

For the branch form, spray with kerosene emulsion, using rather stronger solutions than for other aphides.

NO. 22—GREEN OR APPLE APHIS. (*Aphis mali*).

Infesting the apple, crab apple, and mountain ash. This is one of our commonest and most destructive species, frequently found in great abundance on the leaves, especially of the terminal twigs. The leaves become badly distorted and together with the twigs become blackened from exudations from the insects' bodies.

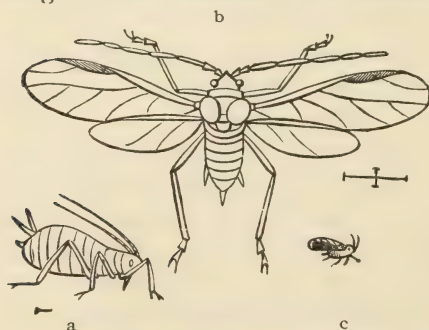


FIG. 41.—Apple leaf Aphis: *a*, wingless female; *b*, winged male, both much enlarged; *c*, natural size.

The eggs are laid usually in large numbers near the tips of branches, especially around the winter buds. They are elongate oval, shining black, and measure about one-twelfth of an inch in length. Shortly after the buds burst in spring the eggs begin to hatch, all producing as in other species, wingless partheno-

genetic females. Some of the later broods consist of winged individuals, and by these the pest is spread from tree to tree. Ex-

cepting for a short time in late summer, when this species migrates to wheat and other grasses, it spends its whole life on the apple tree. (Fig. 41).

Begin to spray for this species as soon as the eggs are hatched. If the first brood is largely destroyed, the later ones are not so likely to be numerous enough to do damage.

NO. 23.—CHERRY APHIS. (*Myzus cerasi*).

This is a black species and is sometimes found on the cherry tree in enormous numbers, usually on the leaves only, but also attacking the tender twigs.

They hatch from eggs deposited the previous autumn on the twigs, and for a few weeks in May and June increase very rapidly. Usually their numerous enemies lessen their numbers so greatly, that they may nearly or entirely disappear after three or four weeks.

In August they appear again, but usually not in such numbers as earlier in the season.

As yet this species does not seem to be abundant in the state, but we have received specimens from nearly every fruit growing section.

NO. 24.—GRAIN APHIS. (*Nectarophora granaria*).

A pale green species infesting wheat, oats, barley, timothy, rye, and other grasses, but especially the first two. Appearing in late June and early July on the under sides of the leaves, but later more abundant on the heads, which they injure considerable by their attacks. The attacks of their numerous enemies lessen their numbers greatly, and after the middle of August it is difficult to find specimens. The eggs and winter habits of this species are not known. (Figs. 42 and 43.)

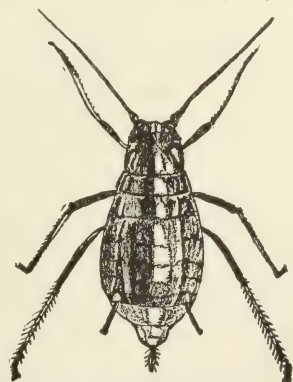


FIG. 42.—Grain Aphis; wingless female.

The grain aphis was introduced into this state last year (1894), probably from California via the



FIG. 43.—Grain
Aphis and
leaf of wheat.

Willamette Valley, and soon spread throughout the wheat growing sections of the state. It is a native of Europe, and was introduced into the United States about thirty-five years ago, reaching California in 1886.

There is no practical method of combatting this insect, which, however, is seldom or never necessary.

NO. 25.—CABBAGE APHIS. (*Aphis brassicae*.)

This species infests the cabbage, cauliflower and mustard. It usually begins to appear in abundance about the time the cabbages are heading. Their bodies are slightly covered with a whitish scurfy substance, giving them a mealy appearance. When very abundant they completely cover the plants, and by crawling in between the leaves of the heads render many of them unfit for food. The entire life of this species is spent on one plant, the winter eggs being found in late fall on the cabbage. (Figs. 44 and 45).



Fig. 44.—Cabbage Aphis;
egg laying female.

NO. 26.—ELM GALL APHIS. (*Schizoneura americana*.)

Infesting only the elm and found usually on the under sides of the leaves, which become thickened and reddish, curling more or less into false galls. This species is slightly covered with a whitish waxy substance and secretes a liquid, which may be found as small globules in the gall. Owing to the protection afforded by the curled leaves, this insect is difficult to kill. The most efficacious remedy is to spray with kerosene emulsion *as soon as the lice appear and before the leaves curl*. Of course if this first brood is destroyed there will be no other.

NO. 27.—ASH LEAF APHIS.—(*Pemphigus fraxinifolii*.)

This species lives on various kinds of ash and causes the leaflets to roll up into false galls much as in the case of the elm-gall aphis, but the curled leaflets remain green. The body of the ash

leaf aphid is covered with a flocculent white wax, similar to the Woolly aphid of the apple. An abundance of liquid is excreted from their bodies, which accumulates in the galls in small globules.

The remarks as to the treatment for the elm gall aphid apply with equal force to this species.

NO. 28.—ROSE LEAF HOPPER. (*Typhlocyba rosæ*.)

Diagnosis.—Attacking the leaves of rose bushes and apple trees on the under side, giving the leaves a diseased, white, spotted appearance on the upper side.

Description and Life History.—All stages of this insect are found on its food plants. The adult is about one-tenth of an inch long, with a yellowish-white body, and white wings. When disturbed it leaps considerable distances, like other leaf-hoppers, but

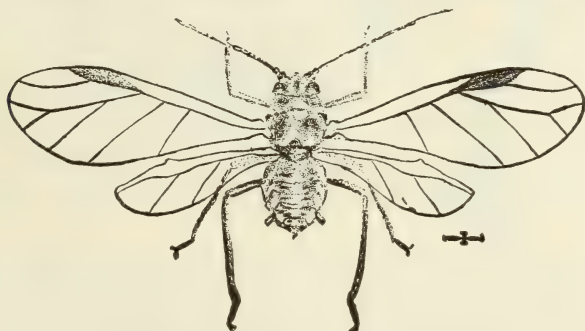


FIG. 45—Cabbage aphid; male, magnified.

its powers of flight are not well developed. The larvæ are whitish tender creatures, and may be found in all stages of growth on the same leaf. The pupa, here called a nymph, is an active creature, differing from the larvæ mainly in possessing rudimentary wings. There are probably several broods each year.

Remedies.—Spray with kerosene emulsion, using an undersprayer. Where it is undesirable to use this substance, pyrethrum or strong tobacco water may be used instead.

Washington Notes.—Common in the counties west of the Cascades, where it seriously injures roses, and likewise apple trees.

NO. 29.—THE IMPORTED CABBAGE WORM. (*Pieris rapæ*).

Diagnosis.—Naked caterpillars feeding on cabbage leaves. The caterpillars are "pale green, finely dotted with black, with a yel-

lowish stripe down the back, and a row of yellow spots along each side." (Riley).

Description and Life History.—The adult is one of the common white butterflies, and may be easily recognized by the accompanying cuts (Figs. 46, 47). The male has a single round black spot near the center of each fore wing; the female has two such spots. With the first warm days in spring these butterflies



FIG. 46—Imported Cabbage Butterfly, male.

appear, and the yellowish oval eggs are deposited singly on the under surface of the cabbage leaves. These shortly after hatch into larvæ, which not only feed on the outer leaves, but also burrow into the heads, attaining their complete growth in from two to

three weeks. They now change to the pupæ, which are greenish, usually on the under side of the leaves, and ten days later emerge as butterflies. The broods are continuous through the season, the number varying in different localities and with the length of the season.

Remedies.—Before the cabbages head, treat with Paris Green or London Purple, using preferably the dry method, as the wet spray does not cling well to cabbage. It is perfectly safe to spray with these substances up to two weeks before using the cabbages. If there is prejudice against using the Paris Green after the cabbages are headed, resort must be had to hand-picking, and as the caterpillars are gregarious, they can in this way be easily controlled.

We have had very little success with such recommended remedies as buhach, hot water, or kerosene emulsion for this insect.

Washington Notes.—This insect is not long introduced in this state, and is not as yet abundant. It is quite sure to become so unless every effort is made to destroy it whenever found. In the east it is the worst of cabbage pests.

NO. 30.—SOUTHERN CABBAGE WORM. (*Pieris protodice*).

Diagnosis.—Very similar to the preceding. The larvæ are greenish blue in color, with four yellowish stripes extending the

whole length of the body, and covered with numerous black dots, each bearing a short hair.

Description and Life History.—The life history is practically identical to that of the preceding insect. The adults closely resemble the imported cabbage butterfly but the females differ remarkably from the males in having their wings very much more marked with black.

Remedies.—Same as for the imported cabbage worm.

Washington Notes.—Native throughout the state, and in the warmer valleys of Eastern Washington, much more abundant and destructive than the preceding species as yet.



FIG. 47—Imported Cabbage Worm. Larva, pupa, and female butterfly.

THE CABBAGE MAGGOT. (*Anthomyia brassicae*).

Diagnosis.—Infesting the cabbage, radish, turnip, stocks, and several other plants of the mustard family; small cylindrical whitish maggots, one-third of an inch long, burrowing into the roots; "the presence of the pest, where it occurs in considerable abundance, is indicated by a checking of the growth of the plant, a tendency to wilt badly under a hot sun, and a sickly bluish cast to the foliage." (Slingerland).

Description and Life History.—The adults are small, black, two-winged, flies, in a general way resembling the common house-fly. They appear very early in spring and deposit their eggs in crevices of the soil close to their food plants. In a short time these hatch into maggots which at once attack the root, in which they make burrows just beneath the bark. The maggots become fully grown in three to four weeks, when they leave the

roots and an inch or two from them transform to pupæ. In transforming, the outer skin of the maggot gradually hardens and becomes separated from the body, forming a *puparium* which contains the delicate pupa. The fully mature puparia are dark mahogany in color and oval in shape. The adults emerge from the puparia usually in from 15 to 20 days, but in some cases this period is very much longer. There are at least two broods each year of this pest, and perhaps three. Usually the first brood in spring does the most serious damage, although the second brood, which appears in late June and July may also cause considerable injury. (Fig. 48).

Remedies.—Slingerland, who has studied this insect exhaustively, finds that an emulsion of carbolic acid is the best insecticide for this pest. The emulsion is made as follows: Dissolve one pound hard soap or one quart soft soap in one gallon of boiling water, into which pour one pint of crude carbolic acid, and then agitate for a few minutes when the whole forms an emulsion which remains stable for a long time. For use, dilute one part of the emulsion with thirty parts water.



FIG. 48.—Cabbage Maggot. *a*, larva; *b*, puparium; *c*, fly.

This substance acts both as a preventive, to a certain extent repelling the flies, and as a direct insecticide. It is to be applied freely to the roots of the plants, first removing the soil so as to expose them. The first application should be made a day or two after setting out the plants, and others every ten or fourteen days until the first of June, after which danger from the first brood is over.

NO. 32—THE CABBAGE PLUSIA. (*Plusia brassicæ*).

Diagnosis.—Attacking cabbage, cauliflower, turnip and more rarely tomato, clover, lettuce and several other plants; the larvæ (caterpillars), are about one inch in length, semi-transparent and pale green in color, with several paler opaque longitudinal stripes.

The head is quite small, with the body gradually enlarging backwards. Damage similar to that of the imported cabbage butterfly.

Description and Life History.—The adult insect is a night-flying moth, expanding about an inch and a half. The front wings are dark grayish or brownish, marked by several broken lines of pale yellow. Near the center of each is a "U" shaped mark and an oval dot, both bright silver in color. The hind wings are smoky gray, paler towards the base. The eggs are laid on the cabbage plants and in a short time hatch into the larvæ, which begin to feed at once, eating holes in the leaves. If very numerous they will eat all but the thick ribs of the leaves. When mature, the larva spins a thin cocoon of silk, sometimes between the leaves, but more often in a better sheltered situation. In this cocoon the larva transforms into a pupa or chrysalis, and after about ten days emerges again as a perfect moth. There are probably but two broods a year in this state. (Fig. 49).

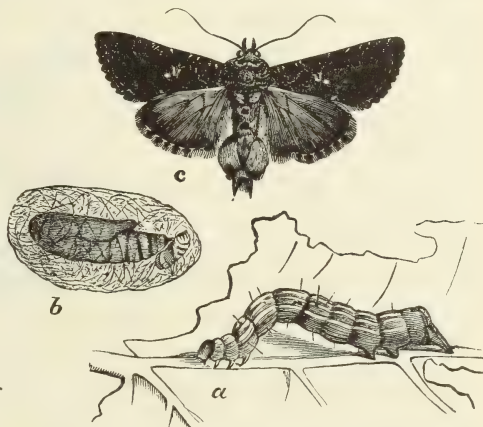


FIG. 49—Cabbage Plusia; *a*, larva; *b*, pupa; *c*, imago.

Remedies.—Same as for the Imported Cabbage Butterfly.

Washington Notes.—Quite rare in the western part of the state, and not yet reported from Eastern Washington. It is sure to become more abundant and destructive unless vigorously combatted.

NO. 33—THE ZEBRA CATERPILLAR. (*Mamestra picta*).

Diagnosis.—Caterpillars feeding on the leaves of cabbage, and easily distinguished from all other larvæ feeding on this plant, by the coal black and brilliant yellow markings on their bodies.

Description and Life History.—The adult insect is a night flying moth, spreading one and one-half inches. The upper wings are dull brownish-purple in color, darker toward the front margin.

Near the center of each is a large grayish spot, peculiarly shaped, and close to it, but nearer the body two other smaller spots, one oval, the other elongate in shape. The under wings are white or nearly so. Owing to its habits, the moth is seldom seen. They first appear early in May, and the small round eggs are laid in clusters on the leaves, and soon hatch into larvæ. These at first are dull in color and feed in groups; as they grow older they scatter. The full-grown larva is about two inches in length, the ground color of the body being shining black. On each side are two bright yellow stripes running the whole length of the body, and connected together by numerous fine lines of the same color. The under side of the body is pinkish yellow. The caterpillars now burrow into the ground to a depth of two inches, constructing there a frail cocoon of particles of earth held together by silken threads, and in these they change to pupæ, emerging about two weeks later as moths. These lay eggs and a second brood of the larvæ appears in August and September, which transform into pupæ and pass the winter in that condition.

Remedies.—The larvæ are easily gathered and destroyed when young, as they then feed in flocks. If they are abundant and scattered, treat the same as for Imported Cabbage Worm.

Washington Notes.—This species is a new comer to the state. We received numerous specimens of the second brood of larvæ from Spokane county in August, 1894. These transformed into pupæ at various dates during September, and the adult moths emerged therefrom late in April and early in May, 1895. Larvæ were also seen in Yakima county in September, 1894. Evidently the insect is yet rare in the state, but it should be destroyed wherever found, lest it become abundant.

NO. 34.—THE CABBAGE PLUTELLA. (*Plutella cruciferarum*).

Diagnosis.—Small, slender green larvæ, varying from one-fourth to three-fourths of an inch in length, on both sides of cabbage leaves; leaves punctured completely through, or all but the skin, with numerous rather small round holes.

Description and Life History.—The adult insect is a small, narrow-winged moth, spreading about one-half an inch. The fore wings are grayish-brown in color, with a rather broad white line on the hinder margin. There are three angles extending

from the white line into the grayish, so that, when the wings are closed, the white forms three diamond-shaped spots. The under wings are dark leaden gray in color. The minute yellowish eggs are laid by the moth on the cabbage leaves, either singly or in groups of three or four. The eggs hatch in a few days into minute greenish larvæ, which at once begin to eat into the leaf. The larvæ shed their skins five times and attain their full growth

in two weeks, being then three-fourths of an inch long. They are slender, green in color, and wriggle very actively when disturbed.

When fully grown the larvæ spin very delicate, gauzy cocoons, usually on the under side of the leaves, and transform

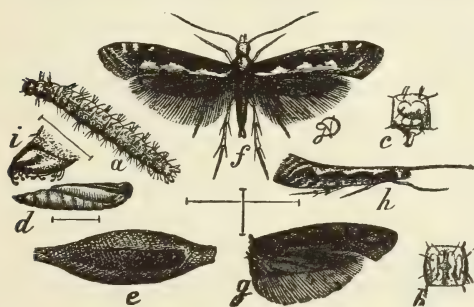


FIG. 50—Cabbage Plutella; a, larva; d, pupa; e, cocoon; f, moth, side view; all enlarged.

therein into pupæ. In seven or eight days the adult insects emerge therefrom. The number of annual broods is difficult to ascertain, but is said to be two as a rule. During July and August all stages of the insect may be found, so that the distinction of the broods is not at all well marked. The winter habits of the insect are not known, but it is probable that it hibernates in the chrysalis or pupa stage. (Fig. 50).

Remedies.—Same as for Imported Cabbage Worm.

Washington Notes.—Common throughout the state, and annually does considerable damage; this was especially true in 1893. In that year we found about one-third of all the larvæ were destroyed by three ichneumon parasites, namely **Herpestonus plutellæ*, Ashm; **Limneria tiliator*, Cr., and **Smicra torvina*, Cr.

A number of other parasites have been recorded for this insect, and doubtless prevent to a great extent the increase of the pest.

NO 35.—THE SMALL-PUNCTURED FLEA BEETLE.

(*Psylliodes punctulata*).

Diagnosis.—Very small shining-black oval beetles eating pits in

*Determined by W. H. Ashmead.

both sides of the leaves of turnips, radishes, sugar beets, potatoes, mustard, pigweed, tumble-weed and many other plants. When disturbed they leap vigorously like fleas, whence their name.

Description and Life history.—The beetles hibernate over winter under stones and appear flying about with the first warm days of spring. At this time they do their most serious damage by eating all the green pulp from the leaves of seedling plants, sometimes utterly destroying a crop. They also seriously injure the plants throughout the season by their attacks. The larval history of this species is not yet ascertained, but it is probable that the eggs are laid near the roots of the plant, and that the larvæ feed on the roots, as in other insects of this family.

Remedies.—Owing to the fact that this insect feeds on so many plants it is difficult to contend with. We have had excellent results using Paris Green liberally. It is especially necessary to protect young plants, and these should be treated as soon as the attacks of the beetle are noticed. Either the dry or wet method of applying the insecticide may be used.

Washington Notes.—This is by far the most destructive flea-beetle in the state, and seems not to occur west of the Cascade mountains. Besides this species more or less damage is done by others, viz, *Haltica ignita*, *Phyllotreta pusilla*, *Phyllotreta decipiens*, and *Phyllotreta oregonensis*.

NO. 36.—THE STRAWBERRY LEAF-ROLLER.

(*Phoxopteris comptana*).

Diagnosis.—Attacking the strawberry. Small greenish caterpillars which fold the leaflets together or roll them into tubes, fastening them by silken threads, and feeding on their substance.

Description and Life History.—These little caterpillars hatch from the eggs about the time the plants are in bloom, and at once make their presence known by their leaf-rolling habits. They become fully grown in June and pupate in their nests, emerging shortly afterwards as a beautiful little moth, measuring less than half an inch from tip to tip of wings. The fore wings are a bright mahogany color, streaked diagonally with whitish lines. Near the posterior outer corner is a small eye-like spot. The hind wings are dirty gray. (Fig. 53).

A second brood of larvæ appears in August and becomes mature in September. This brood passes the winter in the pupa stage.

Remedies.—Two methods are used with success. The better method is to mow the field after the crop is gathered, and after letting it lie a day or two, burn it over. By scattering a little straw on the field, the burning will be more thorough. The plants will quickly recover and send up new leaves.

The second brood may be destroyed by spraying the plants in August with arsenites. The arsenicals must not be used before the crop is gathered.

Washington Notes.—Abundant throughout the state, and injuring the strawberry plants more than any other insect.

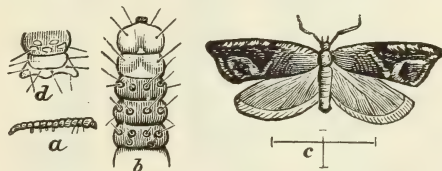


FIG. 53.—Strawberry Leaf-roller. *a*, larva, natural size; *b*, head and four segments of larva enlarged; *d*, the terminal segment; *c*, imago, four times natural size.

MACHINES FOR APPLYING INSECTICIDES.

Notwithstanding that spraying against insects and fungous diseases is a comparatively new thing, the spray pump is today indispensable in the orchard and on the farm. The successful farmer of today must spray; indeed the fact of his spraying may mean the difference between success and failure. Such sorry devices as a broom or a watering can for applying insecticides should be relegated to rest. Spraying is a necessity that pays well if properly done; and to do it well and economically requires special machines. Without these it is almost useless to attempt to fight insects successfully. In spraying machinery as in everything else, the good only is cheap. A good machine pays for itself many times in the rapidity and economy with which it does

its work ; a poor one is a constant source of trouble, and in the end is far more expensive than the good.

It cannot by any means be said that spraying machinery has reached its perfection, still experience has demonstrated that some forms of pumps and nozzles are good, others worthless. No one pump can do all kinds of work equally well, nor can it be expected to.

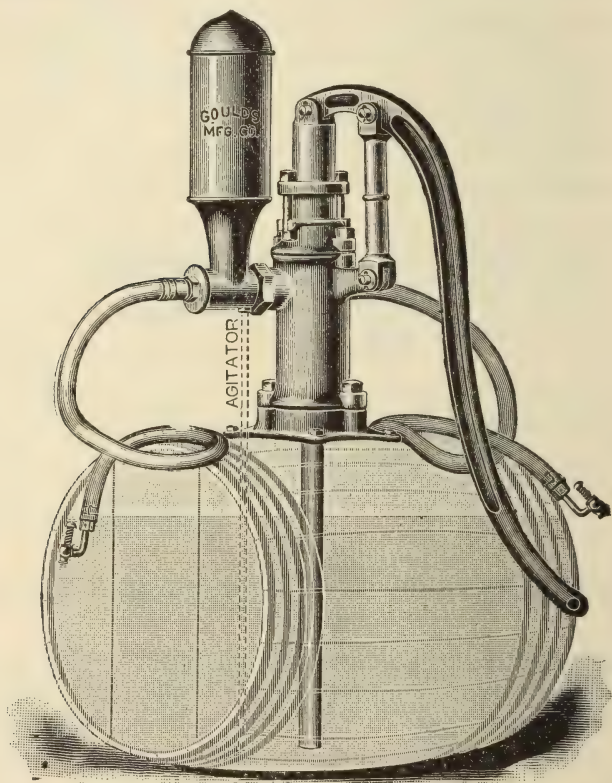


Fig. 54.

Already there are many machines on the market designed for spraying certain crops only, either by hand, horse or steam power. For information regarding any of these we refer the reader to the various manufacturers.

SPRAY PUMPS.

The first requisite for good spraying is a good pump. Although

there are several distinct types on the market, the suction or force pumps are the best for general use. If the pump is to be used at all for spraying Bordeaux mixture or other fungicides, it must be made of copper or brass, or at least lined with those metals. Bordeaux mixture and other copper solutions rapidly corrode iron. Most of the pumps now on the market have their working parts thus protected against corrosion.

It is also important that the pump be so constructed that the



Fig. 55.

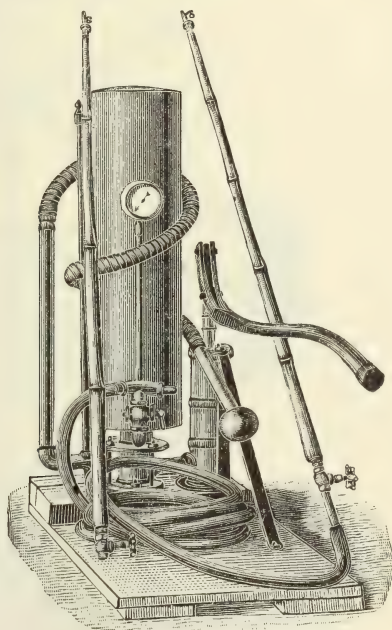


Fig. 56.

working parts are easily accessible. Not infrequently it becomes necessary to take the pump apart to clean or oil it or to renew the valves and packing.

We here illustrate a number of forms intended for general use, but more particularly in the orchard. Nearly all of these pumps have been actually tested here at the Experiment Station.

Fig. 54 represents a pump made by the Goulds Manufacturing Co. It is simple in device, well made, and can easily be taken apart for cleaning. It works easily, and being provided with an

air chamber does not demand continuous pumping. It is sold for \$9.50 without the barrel.

Fig. 55 is a pump made by F. E. Myers & Bro. Price \$12, including hose and nozzle. It is a powerful, well constructed pump, and has a small return pipe so arranged that the spraying liquid is kept in constant agitation.

Most of the eastern manufacturers of spraying machinery make

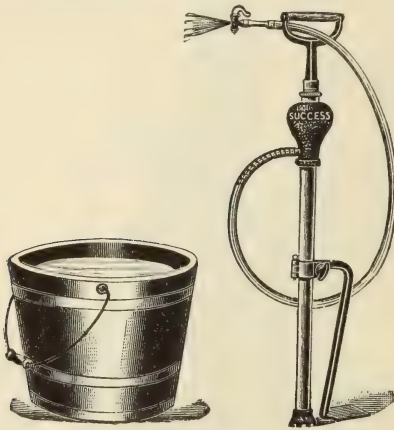


Fig. 55.

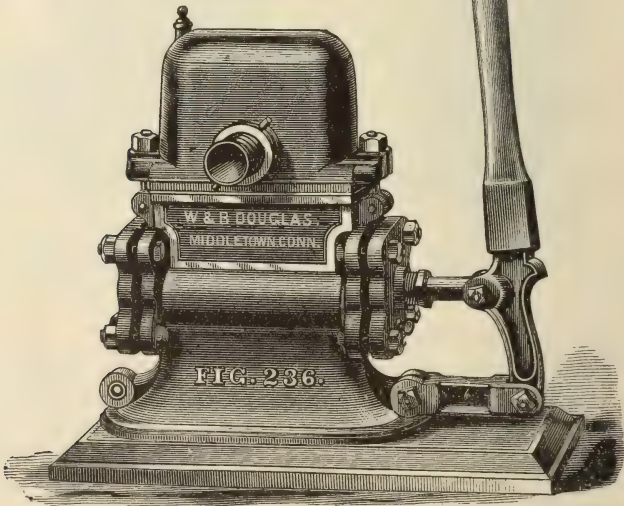


Fig. 57.

pumps similar to these, and for spraying orchards they are excellent.

Fig. 56 is the "Bean" Spray Pump, made by the Bean Spray Pump Co., Los Gatos, Cal. This is perhaps more used in this state than any other spray pump. Its principal feature is the

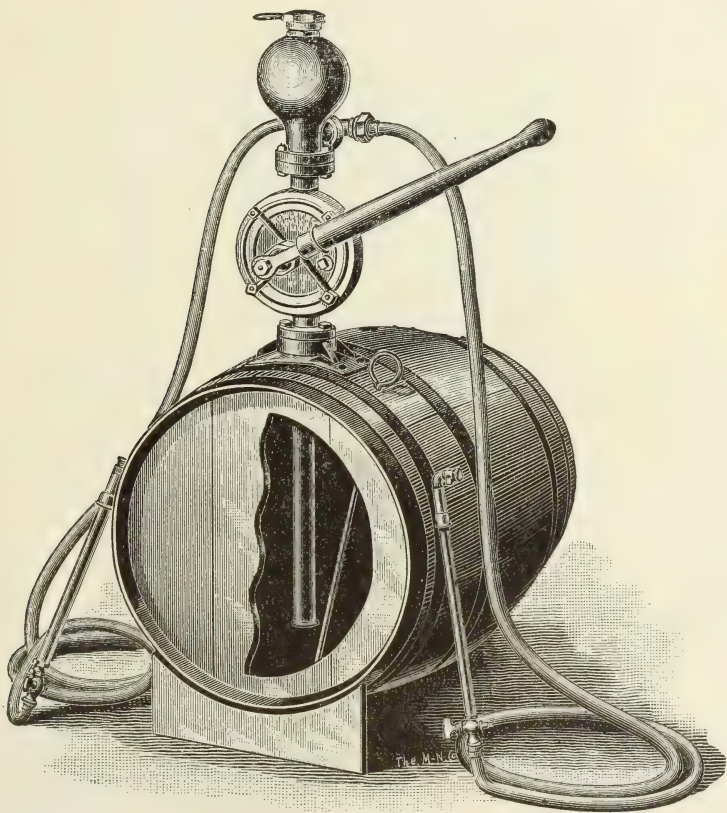


Fig. 59.

very large air chamber, provided with a pressure gauge. When the air chamber is heavily charged, the pump will spray several minutes without pumping. The company makes eight sizes of this pump, ranging in price from \$16 to \$61.

Fig. 57 is a horizontal acting pump made by W. & B. Douglas, designed for use wherever it is desired to throw large quantities

of spraying solution. It varies in price from \$25 to \$200, according to size and construction.

Fig. 58 is the "Success" brass spray pump, made by the Deming Company; price, \$6.00. This is a most excellent little pump designed to be used with a bucket. For light work in spraying as in gardens, we can recommend it highly.

Besides suction pumps, there are several other types of spray on the market. We illustrate one in Fig. 59, the "Watch" spraying pump, made by the Rumsey Company; price, \$10 to \$14. The principle of these pumps is similar to that of rotary pumps. They work easily and do excellent work when new. The working parts however, are made entirely of metal and in time become worn by the gritty spraying liquids; when thus worn the pumps are almost useless.

KNAPSACK SPRAYERS.

For spraying low growing plants, vines or bushes in close rows, the Knapsack sprayer is indispensable. We illustrate in Fig. 60, "The Garfield" sprayer made by the Field Force Pump Company; price, \$12. Similar forms are made by nearly all manufacturers. In purchasing be careful to get a pump in which the discharge pipe enters the top of the tank. Where the discharge pipe leaves the bottom of the tank it is much more apt to become clogged. The Knapsack sprayers are especially useful in spraying low growing crops, grapes and other small fruits.

MACHINES FOR APPLYING DRY INSECTICIDES.

In Fig. 61 we illustrate the Leggett Powder Gun, a machine worked by hand and used to distribute Paris Green, hellebore and similar insecticides whenever it becomes desirable to apply these substances in a dry form. It is simple in construction and well adapted to the purpose for which it is intended. The application of insecticides in a dry state is however, not so economical as in the form of a spray, so we do not recommend it except in special cases, notably for cabbage insects. It is claimed however, that one pound of Paris Green used pure with this instrument will treat an acre of potatoes. The machine is listed at \$7.00.

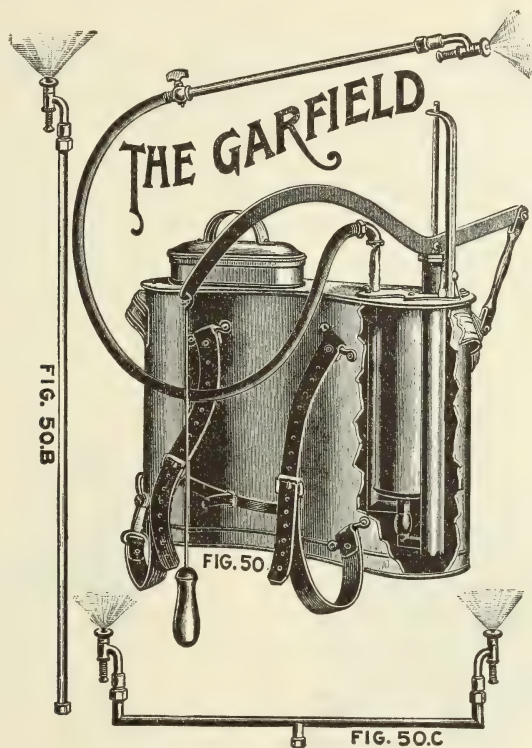


Fig 60.



Fig. 61.

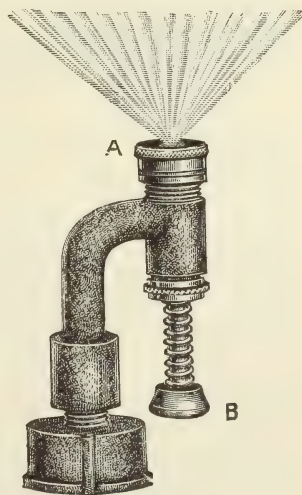


Fig. 62.

NOZZLES.

Not less important than the spray pump is the nozzle to be used in applying insecticides. To be thoroughly efficient nozzles must throw a fine mist-like spray, and be so constructed as to be quickly and easily cleaned if they become clogged. The nozzle that best answers these requirements is the "Vermorel." Being unpatented, it is made in some form by nearly all manufacturers of spraying machinery. The best form is one that is completely separable into its constituent parts, and that has a spring to

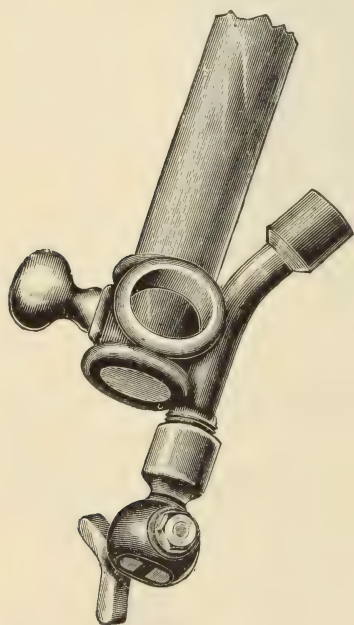


Fig. 65.

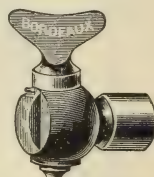


Fig. 66.



Fig. 63.

retract the degorging pin. In Fig. 62 we illustrate a Vermorel made by the Field Force Pump Company; price, \$1.25.

The "Cyclone" nozzle is similar to the Vermorel, but having no degorging pin, is not so quickly cleaned. Some forms of it have the opening in the end, others in the side. The latter form is very useful for spraying the under side of leaves, especially of low plants. We illustrate the Bean "Cyclone," Fig. 63.

A very excellent nozzle is the "Climax," made by the Nixon Nozzle and Machine Co., and shown in Fig. 64. Price \$1.00.

In this the spray is formed by dashing the water against a fine wire screen. This nozzle throws a very fine spray, and for clear liquids and the arsenicals is unsurpassed. With heavy spraying mixtures, however, it is apt to become clogged.

Fig. 65 represents the "Masson" nozzle, made by the Gould's Manufacturing Co. Price \$1.00. This is so constructed that either a coarse or fine spray can be thrown, the change being made by simply turning a thumb-screw. The water is changed into a spray by being dashed against a thin deflected edge. In many respects this nozzle is excellent, but with a careless worker, is not so economical as other forms.

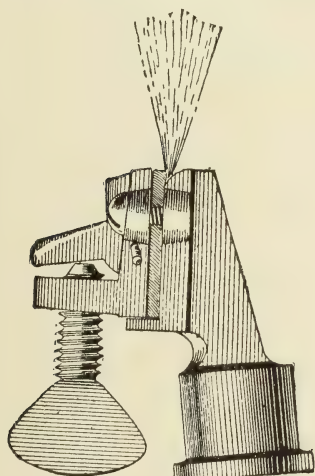


Fig. 67.

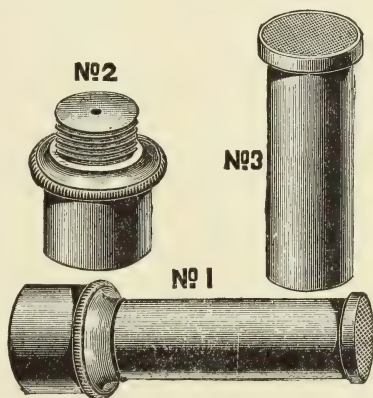


Fig. 64.

The "Bordeaux" nozzle, Fig. 66, is made by F. E. Myers & Bro. Price \$1.50. In general this nozzle is similar to the preceding. Both are very well adapted for spraying heavy liquids, like Bordeaux mixture or the sulphur, lime and salt wash.

The "New Bean" nozzle, Fig 67, is made by the Bean Spray Pump Co. Price \$1.00. The size of the spray is regulated here by a thumb-screw, and the orifice protected by pieces of rubber. It is especially designed for the sulphur, lime and salt wash.

Besides the above, there are many other new nozzles on the market, some of which may prove valuable. The trouble with most of them is the difficulty of cleaning them when they become clogged, and this is a point of no small importance in spraying.

BAMBOO EXTENSION RODS.

For spraying in the tops and center of tall tree this is a very useful device. It consists simply of a light bamboo pole 10 or 12 feet long, through which runs a light iron pipe. The hose can be coupled at one end, and a nozzle placed at the other. By its use the operator can spray the interior of trees with ease and thoroughness, and economy of material.

CARE OF SPRAYING MACHINERY.

When through using, the hose and nozzle should be cleaned by pumping clear water through them. The pump should be taken apart and the valves and bearings cleaned and oiled; otherwise the former will get hard and dry, and as a consequence the pump will do poor work.

MANUFACTURERS OF SPRAYING MACHINERY.

The following reliable firms manufacture spraying apparatus, and will send catalogues on application :

The Field Force Pump Co., Lockport, N. Y.

The Nixon Nozzle and Machine Co., Dayton, Ohio.

William Stahl, Quincy, Ill.

The Gould's Manufacturing Co., Seneca Falls, N. Y.

W. & B. Douglas, Middletown, Conn.

Rumsey & Co., Seneca Falls, N. Y.

Deming Co., Salem, Ohio.

F. E. Myers & Bro., Ashland, Ohio.

William Boekel & Co., 518 Vine street, Philadelphia, Pa.

The Bean Spray Pump Co., Los Gatos, Cal.

Jan, 21, 1896.

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EXPERIMENT STATION

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DEPARTMENT OF AGRICULTURE

THE BABCOCK MILK TEST

By W. J. Spillman

AUGUST, 1895.

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THE BABCOCK MILK TEST.

W. J. SPILLMAN.

The general adoption of the Babcock milk test as the basis of payment for milk at creameries in this state, and the very great value of this test to dairy farmers who are trying to improve their herds, renders it desirable that a bulletin of popular information on the subject should be placed in the hands of those interested. Perhaps no other discovery in the line of dairying has ever been of such importance to the industry as this. It is, in short a method of quickly and easily determining the per cent. of butter-fat in milk, thus giving an index to the amount of butter that can be made from the milk. The per cent. of fat is also a very accurate index to the amount of cheese that milk will make, provided the milk is ordinary unskimmed milk. This test therefore enables the creamery man to pay each patron just what his milk is worth, which is desirable from every standpoint. It also enables a farmer who sells milk, or any of the products of milk, to ascertain which of his cows are the poorest, and thus point out the road to improvement of his herd.

Not Patented.

When the government established the state experiment stations it did the wisest thing any government ever did. It is due to the fact that this milk test was invented by a station worker, that it has not been patented.

The principle was discovered by Dr. S. M. Babcock, of the Wisconsin experiment station, and was published by him in 1890. Since that time it has been almost universally adopted, and has made Dr. Babcock's name a household word in every dairy district in this country.

There are other milk tests, but their inventors, considering money a greater boon than the gratitude of their fellow-men, have patented them, and the apparatus for making them is therefore much more expensive than for the Babcock test.

THE BABCOCK MACHINE ON THE FARM.

NATURE OF THE PROCESS.—The test consists in taking a small quantity of milk (17.6 cubic centimeters), and adding to it the same volume of sulphuric acid. The acid destroys everything in the milk that would rise to the top with the fat, so that when the fat does rise it is pure, and its volume can be measured in the neck of the bottle. The bottle in which the test is made is of a special pattern; the neck is long and slender (see fig. 1, A), and a graduated scale is marked on the neck. The divisions of this scale are such that the length of the column of fat in the bottle neck, measured by this scale, is the per cent. of fat in the milk. The rising of the fat is hastened by putting the bottle in a centrifugal machine which revolves rapidly for about five minutes.

HOW TO GET A FAIR SAMPLE OF MILK TO TEST.—The fat in milk is in very small, round drops. These globules of fat are lighter than the liquid composing the bulk of the milk, and like cork, they tend to rise to the surface. Hence when milk stands, even for a few minutes, the upper layers become richer in fat than the lower. It is therefore necessary to stir a vessel of milk thoroughly in order to be able to dip out a representative sample for testing. It will not do at all to stir simply with a spoon or ladle. This does not mix the top and bottom milk properly. The milk may be properly mixed by pouring it a time or two from one vessel to another, or by dipping out a large cup full and pouring back, repeating the process four or five times, and dipping out the sample immediately afterwards.

An ounce of milk is enough to take for making one test (17.6 cubic centimeters is about two-thirds of an ounce). When the sample is taken to the machine for testing, the exact amount, 17.6 cubic centimeters, is measured out from it.

In getting a sample of a single cow's milk, it must be remembered that cream rises on milk in the udder about the same as in a pan. It would be just the same if the cow stood perfectly still. In milking, therefore, the first milk is poor in fat, the last is very rich. To calculate the butter fat a cow gives at a milking it is absolutely necessary to have an average sample of the milk, and

this can be had only by taking all the milk, first as well as last, and thoroughly mixing it.

There is an apparatus called a "milk thief," that will get an average sample of the milk in a vessel, whether the milk is thoroughly mixed or not. It does so by taking a column of milk extending from bottom to top. It thus gets a portion of the poor milk at the bottom and the rich milk at the top.

It is practically impossible to thoroughly mix curdled or partially churned milk ; hence milk should be tested before it gets in either condition.

Milk may be kept from curdling by adding to it a small amount of powdered potassium bi-chromate, as explained under directions for making the composite test. (See page 18). This substance is poison, and is, of course, added only to the sample to be kept till convenient to test it.

Samples are kept in bottles, or any convenient vessels till tested. The sample should never completely fill the vessel it is kept in, as it must be shaken to mix the milk before testing. (Care must be exercised to avoid churning the sample).

DESCRIPTION OF APPARATUS AND DIRECTIONS FOR MAKING THE TEST.—The samples of milk may be kept in any convenient vessel, such as the ordinary prescription bottles to be found in every household. The sample should not fill the vessel more than half full, as it must be shaken before measuring out the portion for the test. But since the milk to be placed in the test bottle is measured by drawing it up into a pipette (see fig. 1, B) the vessel the sample is in must be of such form that the end of the pipette can be introduced into it. Samples in small necked bottles may be poured out into a tin cup as wanted.

MILK PIPETTE.—Fig. 1, B. When this is full to the mark on the neck it holds just 17.6 c. c. (cubic centimeters). To fill it place the lower end in the milk, take the upper end in the mouth and draw till the milk rises about half way between the mark on the neck and the upper end ; then quickly place the end of the fore finger over the top end. A little practice will enable one to do this quite successfully. By allowing air to enter slowly you can let the milk slowly run out till it falls to the level of the mark on the neck of the pipette. Then holding the finger firmly on the upper end, place the lower end in the neck of the test bottle,

(fig. 1, A), and let the milk run into it. It is supposed that about one-tenth of a c. c. of milk will adhere to the sides of the pipette, so that the amount put in the test bottle is 17.5 c. c., the same as the volume of the acid.

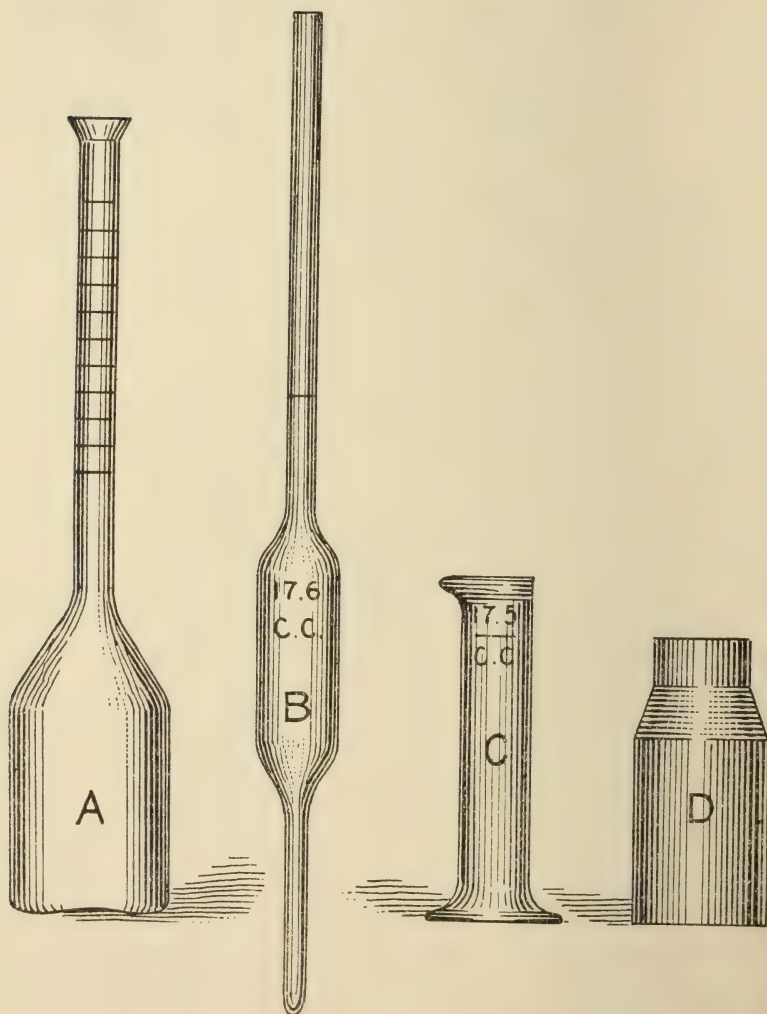


Fig. 1—A, test bottle ; B, milk pipette ; C, acid measure ; D, bottle for milk sample.

Having measured all the samples into the test bottles, the next thing is to add the sulphuric acid. An even number of samples

should be taken, so that the machine will not be thrown out of balance. Two tests of the same sample may be taken if needed.

ACID MEASURE.—Fig. 1, C. The acid is poured directly into this; when full to the mark near the top it holds 17.5 c. c., the amount for one test. Sulphuric acid is very corroding, and if by accident it gets on one's hands or clothing, wash off at once with plenty of cold water. A little ammonia applied afterwards will neutralize what acid might remain, but is not needed except where considerable acid has been spilled, or where the acid has remained long enough to make discoloration of clothing. The acid is now to be added to the milk in the test bottle. In doing this, hold the test bottle (fig. 1, A) obliquely, so that the acid will run down one side of the neck. The acid being much heavier than milk, will run to the bottom of the bottle. If the acid be poured straight down the neck it will usually char part of the milk and spoil the test. The bottle is now about three-fourths full. The milk and acid are now to be mixed. This is done by holding the neck of the bottle and swinging the bowl of it around rapidly in a small circle. This motion puts the liquid contents of the bottle into a rotary motion, which soon mixes them thoroughly. When the acid and milk begin to mix, the milk is at first curdled, then the curd is dissolved. The mixed liquid becomes very hot, a thing that always occurs when sulphuric acid and water are mixed. At first the mixed liquid is of a reddish color, but it soon turns black.

When the curd has been completely dissolved, place the bottle in the centrifugal machine, as shown in fig. 3, or fig. 4; then add the acid to the milk in the next test bottle, and so on, till all the samples have been so treated.

CENTRIFUGAL MACHINE.—This is what is meant when we speak of the Babcock Machine. There are many styles of it on the market. Two different styles are illustrated in figs. 3 and 4. The essential feature of each is that the test bottles are carried around in a circle, and at a very rapid rate. In fig. 4, the bottles are placed in cups hung so that when the machine is running the bottles lie down flat, the tops of the necks pointing inward. The circular motion gives rise to what is known as centrifugal (center fleeing) force; the milk presses against the bottom of the bottle much harder than before; in other words, its weight is several

times multiplied by the motion. The difference between the weight of the fat and of the heavy liquid in which it floats is increased in the same ratio, and the fat rises to the top, or rather toward the center of the machine. Five minutes rapid turning suffices to bring practically all the fat to the surface, where it may be seen as a thin transparent layer. It is melted, as the liquid on which it floats is hot. Hot water is now to be added to bring the fat into the bottle neck, where it can be measured. The

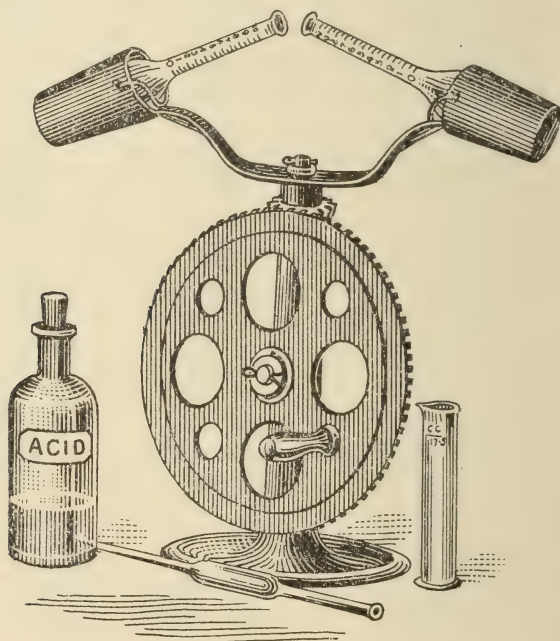


Fig. 3—Babcock Milk Tester.

water should be as nearly boiling as practicable, for it soon cools in the narrow neck of the bottle, allowing the fat to solidify. If the fat does turn solid it should be melted by pouring hot water on the outside of the neck.

HOT WATER.—The hot water may be conveniently added by pouring it first into the acid measure, taking care that no acid is in the latter. (Hot water and sulphuric acid mixed suddenly will explode). Pour from the acid measure to the test bottle. The water should rise into the neck of the test bottle nearly to the

top of the graduated scale. The bottles need not be removed from the machine for this purpose.

When one has a considerable number of tests to make it is desirable to have a more convenient method of handling the hot water. Two very convenient methods are shown in fig. 2. One consists of a half gallon bucket covered by a lid to keep the water hot. Near the bottom on one side is soldered a small tube on which a rubber tube about two feet long is placed. This tube should cost about 25 cents, and the tube soldered in the side of the bucket need not cost more than 10 or 15 cents. In the other end of the rubber tube is fastened a short piece of glass tubing, drawn out to a moderately fine point. This may be had at any

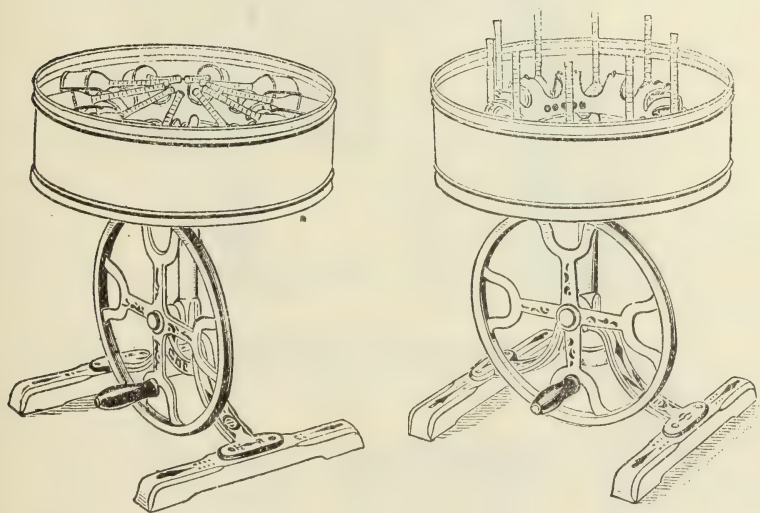


Fig. 4—Another style of Babcock Milk Tester; the cut on the left shows bottles in motion; the one on the right shows them at rest.

drug store for 5 cents. When not in use the rubber tube is laid up over the top of the bucket to keep the water from running out. In running the water into the test bottles, the flow is regulated by pinching the rubber tube. A thick piece of cloth placed between the tube and the fingers will prevent the hot water from hurting the fingers. A split stick on the rubber tube may be used as pincers to regulate the flow of water.

The other apparatus shown in fig. 2 is commonly known as the Spritz flask. It is by far the most convenient and the least ex-

pensive. It consists of a pint, or better, a quart bottle with a wide mouth, (a pickle bottle usually) with a good thick cork to fit it. By means of a rat-tail file two holes are made in the cork, of such size that the glass tubes will fit snugly in them. A glass tube (A, fig. 2) about 6 inches long is bent slightly near one end, and both ends of it rounded by holding in the flame of an alcohol lamp till the glass begins to soften. (Glass tubing is easily bent

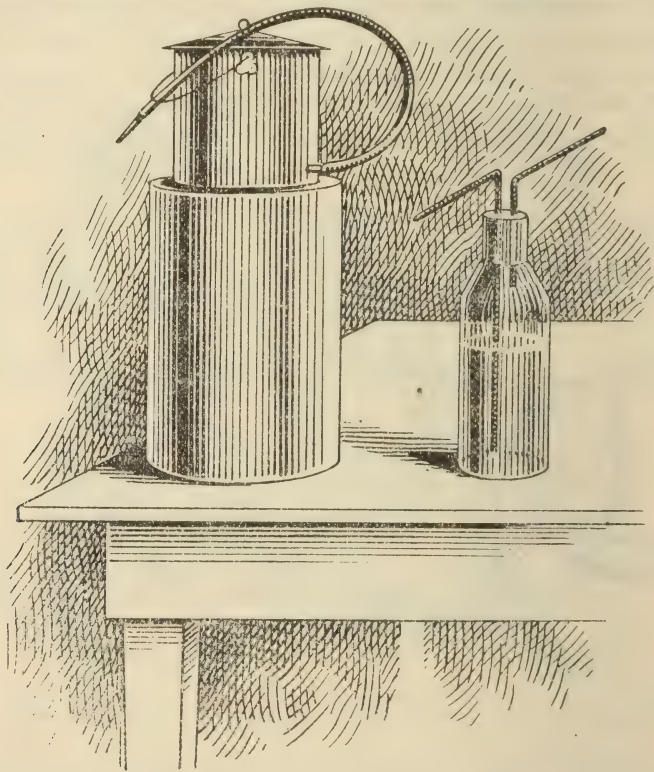


Fig. 2—Two convenient methods of handling hot water for the Babcock milk test.

when heated till it is barely red). The short end of this tube is put through the cork. Air is blown into the bottle through this tube.

Another piece of tubing (B, fig. 2) about 5 inches longer than the bottle is bent as shown in the figure. To get the fine point on the upper, slanting end, heat the tube near the end till it softens, then pull it out till it is about as large as the lead in a pencil.

Let it cool, then break it at its narrowest part, and hold the broken end in the flame an instant to melt down its sharp edge. The tube is then put through the cork as shown in the figure. It should reach nearly to the bottom of the bottle. This bottle, completely fitted up with cork and tubes should not cost over 25 cents. The glass tubing costs only about 5 cents, but the work of bending and fitting is considerable.

Glass tubing may be broken by filing a notch in it with a three-cornered file. Place the thumb on the side opposite the notch, and press against the thumb. The tube will usually make a clean break at the notch.

An alcohol lamp, to be found in any drug store, is very handy for bending glass tubing, rounding off sharp edges, drawing out to a point, etc.

If the tubes are not air tight in the cork, run a little melted sealing wax around them on the upper side of the cork.

To use this apparatus, fill the bottle with hot water, put in the cork with the tubes in it. By taking the end of tube *a* (see figure) in the mouth and blowing through it, a fine stream of water is made to issue from the point of tube *b*. This stream may be directed into the tops of the test bottles in filling them.

Be careful when letting loose of the tube with the mouth that the steam does not blow back into the mouth.

Be careful also not to run the test bottle over when blowing in the hot water. This spoils the test. Do not allow the water in the test bottle to rise above the top of the graduations on its neck.

Having added the hot water to each test, turn the machine again for a minute or two, to make sure that all the fat rises into the neck.

READING THE PER CENT. OF FAT.—The neck of the test bottle is graduated so as to read from no per cent. up to ten. The distance between the longer marks represents one per cent. This distance is divided by shorter marks into five equal parts. One of these smallest divisions therefore represents two-tenths of one per cent.

Now suppose the upper end of the fat column stands at the second short mark above 8. This is 8.4. If the lower end of the fat is at the fourth short line above 3 it is at 3.8. The length of

the fat column is therefore $8.4 - 3.8 = 4.6$, which means that the milk tested contains 4.6 per cent. fat.

If the bottom of the fat stood half way between say the first and second divisions above 3, it would be read 3.3, which is half way between 3.2 and 3.4.

A quicker way to read the per cent. is to place the point of one leg of a pair of dividers (compasses) against the neck of the test bottle opposite the bottom of the fat column; place the point of the other leg at the top of the fat column. Then, without closing or opening the dividers any, place the end of the lower leg at the zero mark; the other leg will point out directly the per cent of fat.

In reading the height of the upper surface of the fat column, a difficulty will arise. That surface is curved, badly so if the fat has begun to solidify. The center of the surface is lower than the outer part. Be sure the fat is liquid—pour hot water on the neck if necessary—then read the height of the edge, not the center, of the upper surface of the fat.

CLEANING THE BOTTLES, PIPETTE, ETC.—The test bottles are emptied (melt the fat in the neck if it has cooled), taking care to shake the contents as they run out, to remove the white sediment in the bottom. Then fill with hot water (or better with hot soap suds); pour this out, shaking the bottle to rinse it as the hot water runs out. The bottles should now be placed so they will drain, when they are ready for use again.

To cleanse the milk pipette, draw it full, first of cold water, and rinse by shaking. This should be done before the milk dries on its inner surface. Then rinse in same manner with hot water or soap suds.

The acid measure is cleansed by simply rinsing with cold water.

SULPHURIC ACID.—This is a heavy, oily looking liquid, which in its pure state is colorless. A small bit of cork or other organic matter dropping into it turns it dark, or even black. This, however, does not injure it materially for our purpose. It is best kept in glass stoppered bottles. If these are not at hand, rubber stoppers should be used, as corks are eaten up by the acid. Care must be exercised to prevent coming in contact with the acid, as it burns the skin, and eats holes in cloth, turning most colored woollens red. Cold water applied promptly will remove it, and

ammonia (hartshorn) will usually restore the color of woollens discolored by it.

The strength of the acid should be such that its specific gravity is between 1.82 and 1.83, which means that it should be 1.82 to 1.83 times as heavy as water. When the acid has no water in it, its specific gravity is 1.84. It is supposed to be of the right strength as it comes from the dealer. At the end of this bulletin is a list of dealers who furnish it of that strength. The Elgin Dairy Report, Elgin, Ill., sells for 35 cents, post paid, a small float, which tells you if the acid is of the right strength.

If the acid is too strong it will partially char the fat, so that a black clot collects at the bottom of the column, making it difficult to read. Do not try to weaken the acid by adding water; there is danger in this. Simply use a little less acid than is called for. A few trials will tell you how much to use.

If the acid is too weak it will not dissolve quite all the white curd. In this case use a little more acid. If this does not suffice, throw it away and get a better quality.

It should be remembered that the mixed milk and sulphuric acid cannot be thrown into wooden or tin vessels. A glass fruit jar, or an old earthenware jar or crock makes a good slop bucket to use in testing milk.

COST OF ACID.—Sulphuric acid costs about 35 or 40 cents a gallon, plus freight. The freight on it is double first class rates. So by finding out what the rate is from Chicago, you can estimate what it will cost you. A gallon contains 15 pounds of the acid. In figuring freight, add to this the weight of a gallon jug. One gallon of acid will make about 290 tests. One pound makes 25 or 26. It is best to order it of some creamery supply company, in gallon lots, to be sent by freight.

To Find the Pounds of Butter Fat.

To find the number of pounds of butter fat in a given quantity of milk, it is only necessary to multiply the number of pounds of milk by the per cent. of fat, as found by means of the Babcock machine. Thus, suppose in the above case where the per cent. of fat was 4.6, that there is 16 pounds of the milk. $16 \times .046 = .736$ pounds. (When multiplying by the per cent. of fat, remember to express it decimally; thus, 3.4 per cent. would be written .034; 4 per cent. .04, etc.)

Does it Pay to Buy a Machine?

If a farmer keeps the milk from each cow separate, makes the separate lots into butter, and sells it, he knows just what each cow is doing for him. He has no use for a milk tester. But by means of a Babcock machine he can mix the milk all together, and still know just what each cow is doing. This is done by weighing each cow's milk, and testing an occasional sample. A pair of spring scales hung up in the barn near the milking place makes the weighing the matter of a minute.

A VERY IMPORTANT QUESTION.—Does it pay to know just what each cow in a herd is doing?

A good cow eats in a year's time about \$35 worth of feed. The labor necessary to do the feeding and milking, and looking after the milk, costs, at ordinary wages, about \$15, making the cost of a year's keep about \$50. Now, after crediting the cow with a \$5 calf, she must yield butter worth \$45. This will require 225 pounds of 20 cent butter, or 300 pounds of 15 cent butter. The farmer who is selling butter, or selling milk to a creamery or cheese factory, and who has a cow that gives less than 225 pounds of butter a year, could make more money by shooting the cow, selling the feed, and hiring to his neighbor at ordinary wages. When it is remembered that the average cow in the United States makes about 130 pounds of butter a year, it is seen that thousands of farmers are working for less than common wages.

There are herds of dairy cows, scrub cows too, if you please, that give 300 pounds of butter fat a year, or even 350 pounds. But their owners stand over them with a Babcock machine in one hand and a butcher knife in the other. That is what the progressive farmer in this state is going to do; and when he learns to do so with judgment, he will find dairying distinctly profitable.

Variations in Per Cent. of Fat.

It has been found that a cow's milk grows gradually richer as it decreases in quantity; that is, as the period of lactation advances

The following figures, from Illinois bulletin 24, shows the average per cent. of fat for each month in milk for a number of cows:

	Cow No. 1	Cow No. 2	Cow No. 3	Cow No. 4	Cow No. 5
1st Month.....	4.5	3.7	3.5	3.3	2.9
2nd Month.....	4.6	3.2	3.9	3.6	2.8
3rd Month.....	4.7	3.3	4.0	3.8	3.3
4th Month.....	4.9	3.7	3.9	3.7	3.2
5th Month.....	4.6	3.7	3.9	4.0	3.1
6th Month.....	4.9	3.8	3.9	3.6	3.4
7th Month.....	5.4	3.7	3.9	4.0	3.6
8th Month.....	5.2	3.6	4.1	4.3	3.7
9th Month.....	5.7	3.8	4.1	4.0	3.8
10th Month.....	6.3	4.0	3.9	3.8	4.0
11th Month.....	6.4	3.8	4.0	4.0	...
12th Month.....	...	3.9	...	...	...
13th Month.....	...	4.2	...	...	...
14th Month.....	...	4.7	...	...	...

In each case the milk grows richer in fat the longer the cow has been in milk, though the increase is by no means regular in some cases. It is tolerably regular with Nos. 1 and 5.

DAILY VARIATION.—In order to obtain some definite figures to illustrate the daily variation in per cent. of fat, the milk from two cows in our station herd was tested night and morning for two weeks, with the following result :

1895.	Cow No. 1	Cow No. 2	1895.	Cow No. 1	Cow No. 2
March 9.....	{4.2 4.0	4.6 4.2	March 16.....	{4.2 4.1	4.6 4.2
March 10.....	{4.4 —	4.2	March 17.....	{4.0 4.1	4.4 4.3
March 11.....	{4.0 4.2	4.5 4.2	March 18.....	{4.0 4.0	4.6 4.4
March 12.....	{4.1 4.2	5.2 4.4	March 19.....	{4.1 4.4	4.8 4.4
March 13.....	{5.0 4.0	5.0 4.2	March 20.....	{4.0 4.0	4.8 4.2
March 14.....	{4.0 3.8	4.8 4.0	March 21.....	{4.4 4.2	4.2 4.1
March 15.....	{4.0 4.0	4.2 4.0	March 22.....	{5.0 —	4.8 —

These tests were made by Mr. C. J. Oberst, a student of the college.

The amount of the daily variation may be much greater than here shown. These cows were kept under fairly uniform conditions. In cases where cows are subjected to excitement of any kind the variation may be very great. In the Illinois bulletin

above referred to a certain cow, on June 29, gave milk containing 2.8 per cent. fat ; the next day it was 6.6 per cent. These variations can not always be accounted for. Some cows give milk that is very constant in composition ; others are just the opposite. As much depends on the individuality of the cow as on anything else.

The casein and other constituents of milk also vary in a manner very similar to that of fat, but their variations are seldom so great.

The per cent. of total solids (fat, casein, albumen, milk sugar, and mineral matter) in milk gradually increases the longer a cow is in milk.

THE BABCOCK MACHINE IN THE CREAMERY.

So far as the writer is aware, all the creameries in this state use the separator system of creaming. The gathered cream plan pursued in many of the older dairy districts finds little favor here. This is very fortunate, for not only is there far less loss of fat with the separator system, but the quality of the butter can be made uniformly better. However, it is thought best to discuss the use of the Babcock Milk Test in both classes of creameries, as it is equally important to each where they exist, and it is probable that some gathered cream creameries will be established from time to time.

In Separator Creameries.

By means of what is known as the composite test, it is possible to ascertain exactly how much butter fat is brought to the creamery by each patron without the trouble of testing the milk every day.

The composite test is therefore almost, or quite, universal in creameries using the Babcock Machine. It differs in no way from the test as described in the preceding pages, except that the samples taken daily are kept to the end of the week, or other convenient time, and then tested. They are kept from curdling by

adding to them potassium bichromate, or any one of several other poisons, as explained below. It is called a composite test because all the samples from the milk of a given patron are mixed together and the mixture only is tested. The sample taken each day is simply poured into the vessel containing that of the day before, and so on till testing time.

RECEPTACLES FOR SAMPLES.—The samples are usually kept in glass jars holding about a quart. Ordinary fruit jars are suitable. Dealers in dairy supplies furnish jars made for this purpose; they cost about the same as fruit jars, and are perhaps slightly better adapted to the work.

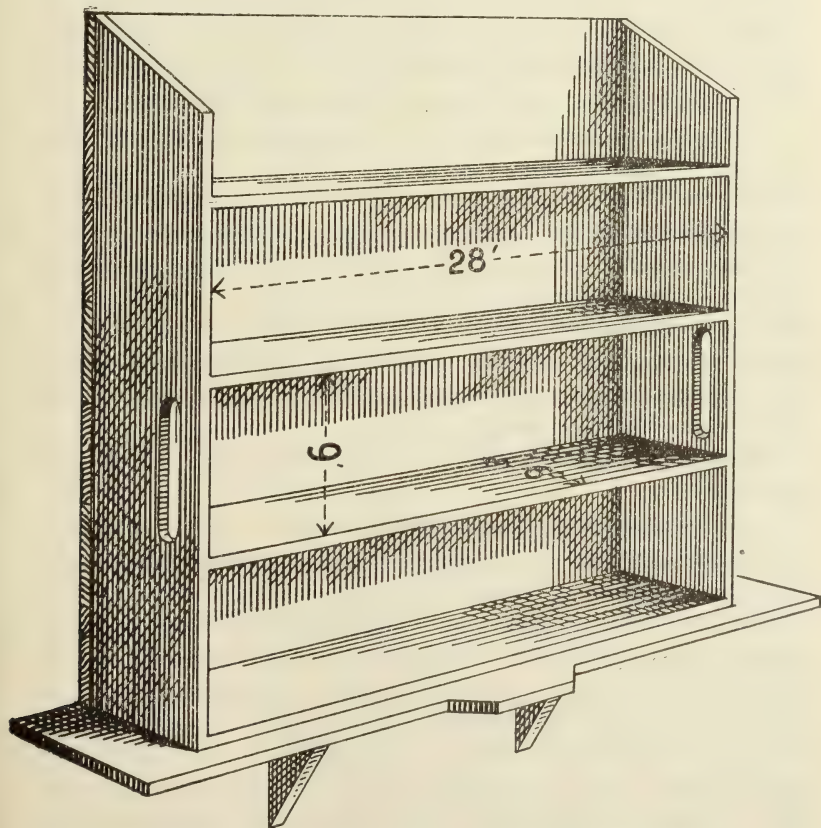


Fig. 5.—Portable rack for sample jars (will hold 32 pint jars, or 28 quart jars). The small shelf in front will be found very convenient to set jar on when putting in sample, or when taking out to test.

SHELVES FOR SAMPLE JARS.—Figure 5 shows a convenient form of portable shelves for holding the samples. These shelves stand near the weigh-can. Hand holes at the sides make it convenient to carry them to the Babcock Machine when ready for testing. When more than 24 jars are in use it is best to have two sets of shelves, as more than that number would be inconveniently heavy, and the danger of accidents thereby increased. In case of accidental loss of a composite sample, as fair a way to do as any is to replace it by the average of the preceding and the following test, unless it happens to be known that the result of the preceding or the following test would alone be nearer the correct figure. In case a considerable change should be made in the herd of a patron, as by sale or purchase, just before the sample is lost, the following sample would probably be nearer the lost one than would the average of the one before and the one after.

PRESERVING THE SAMPLE.—A sample that has become curdled can not be fairly tested; it is therefore necessary to prevent curdling. This is done by placing in each sample-jar a small quantity of potassium bichromate, or any one of a number of such poisons. Whatever is used should be in the solid form, and should be powdered unless it is very readily soluble in the milk. One great advantage of potassium bichromate is that it imparts a lemon or orange color to the milk, and no one is liable to mistake it for ordinary milk, and thus get poisoned by drinking it. This material is also quite cheap.

The poison should be placed in the jars before any samples are put into them.

QUANTITY OF POTASSIUM BICHROMATE TO USE.—One-fourth to one-half gram of this substance will keep a pint to a quart of milk from curdling for a week. One gram of powdered potassium bichromate is about what would lie on a copper cent. A little practice will enable one to guess with sufficient accuracy the proper amount. The idea is to keep the milk from curdling, yet not to use any more of the poison than is necessary. A large excess is said to interfere with the accuracy of the test. A little too much is better than not quite enough, for the latter spoils the test. Enough should be used to give the milk a light straw color.

PRECAUTIONS IN TAKING SAMPLES.—If samples are taken by means of a dipper or cup, care should be exercised to see that the

milk is thoroughly stirred up when the sample is taken. Thorough mixing can be accomplished by taking a large dipper (half gallon at least) and dipping up and pouring back several times. The milk is usually pretty well mixed immediately after pouring it into the weigh-can from the delivery cans.

The size of the sample should also correspond with the amount of milk from which it is taken. An illustration will show why. Suppose A brings in to-day 100 pounds of milk, containing 4 per cent. fat, to-morrow he brings 50 pounds, containing 5 per cent. fat. The first day he brings 4 pounds of fat and the second, $2\frac{1}{2}$ pounds, or $6\frac{1}{2}$ in all. Now if equal samples of these two days' milk were taken and mixed, the mixture would test $4\frac{1}{2}$ per cent. showing $150 \times .045 = 6.75$ pounds of fat, or $\frac{1}{4}$ pound more than was actually brought. But if the sample on the second day had been only half as large as that on the first, the mixed samples would have tested $4\frac{1}{3}$ per cent. and $150 \times .04\frac{1}{3} = 6.50$, which is correct.

This error does not occur unless the milk varies both in quantity and richness, but as both of these vary to some extent, it is a little fairer to make the size of the sample correspond to the amount of milk. There are a number of implements for taking samples that accomplish this. The "Milk Thief" is such an instrument. It takes a small column of milk, just as long as the milk is deep, hence the amount taken depends on the amount of the milk. This instrument also gets a fair sample from milk not thoroughly stirred up, as it takes milk from the bottom, middle and top of the vessel alike.

In the absence of a "Milk Thief," or some similar device, a very convenient form of dipper is a small cylindrical cup, with a long wire handle soldered to one side of it. The cup should hold about an ounce of milk. It may be 1 inch in diameter and $2\frac{1}{4}$ inches deep, or $1\frac{1}{4}$ inches in diameter and 1 inch deep. The latter form is preferable, because it can be more easily cleaned. When a sample is added to a jar it should be mixed with that already in the jar. In doing this, be careful not to churn the mixture. Give the jar a circular motion, causing the milk inside to flow round and round until the cream is all washed from the sides of the jar. The sample will then be sufficiently mixed. All samples to be kept for some time should be shaken this way occasionally to prevent the cream from hardening on the surface.

PROCESS OF TESTING.—The composite samples are tested in exactly the same manner as already described for single samples. Carefully mix the sample by stirring as above before measuring out the portion for the test. The accuracy of the test depends largely on the thorough mixing of the sample.

A FREQUENT DIFFICULTY.—There is some times found at the bottom of the fat column in the neck of the test bottle a mass of black material that renders it uncertain just where the bottom of the column is. Some times also there are small white clots that interfere in the same way.

The presence of the black material, which is a portion of the fat charred by the acid, may be due to one of three things :

FIRST.—The acid may have been poured into the test bottle so as to drop down through the milk, instead of running down on the inside surface of the bottle as it should do.

SECOND.—The acid may be too strong, in which case, use a little less of it, or cool the milk before adding the acid.

THIRD.—The milk may have been too warm.

When the acid is of proper strength, the temperature of the milk should be between 60° and 70° F. If the acid is too strong, good results can usually be obtained by making the milk cooler ; if too weak, make the milk warmer.

HOT WATER.—Where the number of tests to be made is as large as it must be in any creamery, some convenient means of handling hot water is required. Either of the devices shown in fig. 2 is very convenient. It is better, however, to have hot water brought near the machine from the pipes in the building ; a small faucet with a rubber tube attached similar to the tube shown in fig. 2, A, completes the hot water arrangements.

COMPUTING DIVIDENDS.—In order to know how much is due each patron the first thing necessary is to ascertain how much butter fat he has furnished. To do this, multiply the per cent. of fat in each composite sample by the number of pounds of milk from which that sample was taken ; if more than one composite sample has been tested for each patron, calculate the pounds of fat for each test separately and add the results.

To illustrate : Suppose we are to calculate the pounds of fat furnished by A from July 1 to 27 inclusive. Suppose four com-

posite samples have been taken, the first on July 1-6, the second on the 7-13, the third the 14-20, and the fourth the 21-27.

During each of these four periods the pounds of milk and the corresponding per cent. of fat was as follows :

July 1-6, 750 lbs., per cent. of fat.....	4.2
July 7-13, 765 lbs., per cent. of fat	4.1
July 14-20, 740 lbs., per cent. of fat.....	4.3
July 21-27, 745 lbs., per cent. of fat.....	4.2

The calculations are as follows :

$$750 \times .042 = 31.500.$$

$$765 \times .041 = 32.365.$$

$$740 \times .043 = 31.820.$$

$$745 \times .042 = 31.290.$$

$$125.975 \text{ lbs.}$$

It is thus seen that a separate calculation should be made so as to show the number of pounds of fat furnished each week, or each test period when the periods are other than a week.

It should be remembered when multiplying that 4 per cent. = .04, 3.5 per cent. = .035, etc.

Having now ascertained the number of pounds of fat furnished by each patron, it remains to find how much is due each of them. The manner of doing this depends on the agreement between the creamery and its patrons.

FIRST METHOD.—Some creameries agree to pay simply so much per pound for butter-fat furnished, the price usually bearing a fixed relation to the price of butter. Where this is done, the amount due each patron is found by multiplying the number of pounds of fat furnished by the stipulated price per pound.

SECOND METHOD.—Several of the creameries in this state charge so much a pound for manufacturing and marketing the butter, dividing the remainder of the proceeds of sales between the patrons. The method of computing dividends under this system is illustrated by the following example :

The total pounds of fat furnished by all patrons during a given four weeks is 9750. This has been made into 10562.5 pounds of butter, which has been sold for 22 cents a pound. The creamery charges are five cents a pound of butter. What is A's dividend if he furnished 120 pounds of fat during the four weeks?

Solution : $22c - 5c = 17c$; 10562.5 pounds butter, at 17 cents a pound amounts to \$1795.625, the amount due patrons. Dividing this by 9750, the number of pounds fat furnished, we have,
 $\frac{1795.625}{9750} = \0.1841 The price patrons receive per pound of fat.
 A's dividend is therefore $120 \times .1841 = \$20.09$.
 We may state this method in the following

Rule for Computing Dividends.

Deduct the fixed creamery charge from the price for which the butter was sold. Multiply the pounds of butter made during the given time, by the remainder. Divide this product by the total fat furnished by patrons during the time. Multiply this quotient by the number of pounds of fat furnished by each patron. The result will be the amounts due each patron.

The above rule consists of four operations : The first gives the price patrons are to receive per pound of *butter*.

The second, the amount to be divided between the patrons.

The third gives the price per pound of *fat*.

The fourth gives each patron's dividend.

The above method is a popular one. It is also well adapted to co-operative creameries.

THIRD METHOD.—A third method is sometimes used, but the principle of it is essentially that of the first method given above. It consists in paying so much per hundred pounds of 4 per cent. milk. If the price of 4 per cent. milk is fixed at 80 cents, then 1 per cent. milk would be 20 cents ; 2 per cent., 40 cents ; 5 per cent., \$1.00, etc.

Any of the above methods is as fair as another, if prices be properly adjusted. They are all three in use in creameries in this state.

Detection of Losses.

The work of the Babcock Machine in a creamery does not stop with calculating dividends. One of its most important uses is the detection of losses in skim and butter-milk. In a well conducted creamery investigated by the Connecticut experiment station the loss of fat in separator and churn amounted to $7\frac{1}{2}$ per cent. of the total fat in the milk used. That is, in every \$100 worth of fat, \$7.50 worth of it was wasted. In poorly conducted creameries,

and in most farm dairies, the losses are far more than this. It is, therefore, important that every creamery should occasionally test its skim-milk and butter-milk in order to know if there are any preventable losses. With present appliances, with careful management, a creamery may expect to recover in the butter about 92 per cent. of the fat in the milk.

TESTING SKIM-MILK AND BUTTER-MILK.—The ordinary test bottles are not satisfactory where accurate tests of skim and butter-milk are desired. Special bottles are to be had for this purpose, holding twice as much as the ordinary ones, thus making the fat column twice as long. In making the test with these bottles, two pipettes of milk and two measures of acid are used.

In Gathered-Cream Creameries.

This class of creameries was formerly much more common than now, the superiority of the separator system having gradually driven them out. Under the gathered-cream system, the cream-gatherer makes the rounds of the farms and collects the cream which has been allowed to rise in cans kept by the farmer. These cans are usually of special construction and of certain size, so that the amount of cream can be quickly measured. The cream-gatherer, when the Babcock Machine is used, takes with him a case of sample bottles, and each morning takes a sample of the cream, and also the weight of the cream before putting it into his cans.

The necessity of paying for cream by fat content, rather than by volume, is apparent from the statement that in a single trip of a gatherer for a Connecticut creamery the per cent. of fat in the samples of cream taken varied from 14 per cent. to 24 per cent., and this is not an unusual variation.

Great care must be taken in getting test samples of cream to see that the cream is thoroughly mixed. Special test bottles are provided for testing cream. Most of them are to be used exactly as ordinary test bottles, the manipulation being precisely the same as for whole milk. The special feature consists in a wide neck so that the fat column will not be so long, or a swollen place in the neck, with graduations above and below. In using the latter, the amount of hot water added to the test bottle should be sufficient to bring the upper surface of the fat above the swelling, while the lower surface should be below it.

THE BABCOCK MACHINE IN THE CHEESE FACTORY.

It is generally supposed that the casein (that which rennet curdles) is what makes cheese, and that for this reason the Babcock machine has no business in a cheese factory. It will therefore be surprising to many to know that the butter fat in milk is as good an index of the amount of cheese the milk will make as it is of the amount of butter it will make.

Here are some figures in this connection, obtained from a long series of carefully conducted experiments by the New York station :

One hundred pounds of milk containing 3 per cent. of fat made $8\frac{1}{4}$ pounds of cheese with the following composition.

Butter fat.....	2.72 pounds
Casein.....	1.90 pounds
Water and salt.....	3.63 pounds
Total.....	8.25 pounds

Of milk containing 4 per cent. fat, 100 pounds made cheese composed of

Butter fat.....	3.70 pounds
Casein.....	2.57 pounds
Water and salt.....	4.73 pounds
Total.....	11.00 pounds

The cheese from 100 pounds of 4 per cent. milk contained

Butter fat.....	4.68 pounds
Casein.....	3.05 pounds
Water and salt.....	5.65 pounds
Total.....	13.38 pounds

In every case, there was more fat than casein in the cheese.

In the case of the 3 per cent. milk, there was 2.75 pounds of cheese for every pound of butter fat in the milk ; with 4 per cent. milk there was 2.75 pounds of cheese again for each pound of fat in the milk ; with 5 per cent milk, there was 2.67 pounds of cheese for each pound of fat in the milk. From this we can deduce the following rule: To find the pounds of cheese a given quantity of whole milk will make, multiply the pounds of fat in the milk by $2\frac{3}{4}$.

The injustice of buying milk by quantity at a cheese factory is as great as it is at a creamery. The Babcock machine is worth just as much to the rich-milk patron of a cheese factory as of a creamery.

This rule does not apply to skim-milk, only to whole milk. The reason is this: The amount of casein in whole milk bears nearly a constant ratio to the amount of fat. Thus, if one cow's milk contains twice as much fat as another's it will contain twice as much casein too. In this connection, some figures from the New York Experiment Station Bulletin No. 68, will be interesting. They are given in the table below. Column I gives the number of samples tested; II, the average per cent. of fat in them; III, average per cent. of casein; IV, average pounds of casein for each pound of fat.

I. No. Samples.	II. Per Cent. Fat.	III. Per Cent. Casein.	IV. Pounds Casein to 1 Pound Fat.
22	3.35	2.20	.66
112	3.72	2.46	.66
78	4.15	2.70	.65
16	4.74	3.05	.64
7	5.13	3.12	.61

The per cent of fat and of casein increase together.

This shows why, in whole milk, the per cent. of fat is an index to the amount of cheese that milk will make. It will be noticed that when the milk is very rich in fat, the amount of casein does not increase quite so fast as the fat, and hence very rich milk will not make quite as much cheese as the above rule calls for; but the quality of the cheese from rich milk is so much better than that from poor milk that the difference is fully made up in the higher price the cheese will bring.

The information contained in the following pages will be of interest, both to creamery men and to dairy farmers.

Composition of Milk, Butter and Cheese.

Dairy products vary greatly in composition. The table below gives the *average* composition from many analyses:

PERCENTAGE COMPOSITION OF DAIRY PRODUCTS.

	Water	Fat	Casein	Al- bumen	Milk Sugar	Mineral Matter
Milk.....	77.	4.	2.60	.70	4.95	.75
Skim Milk.....	90.25	.3	2.75	.75	5.15	.80
Butter Milk.....	90.50	.5	2.40	.60	5.30	.70
Cream.....	74.05	18.8	2.	.50	4.15	.50
Whey.....	92.97	.5	.15	.78	5.00	.60
Butter.....	14.10	85.	.60	.15	0.00	.15
Cheese.....	33.25	35.5	24.65	0 00	4.50	2.10

When 100 pounds of average 4-per cent milk is made into butter by ordinary creamery methods, there results, on an average

Skim milk.....	80.	pounds
Butter milk.....	15.67	pounds
Butter.....	4.33	pounds

Total..... 100.00 pounds

When made into cheese, the results are

Whey.....	90.	pounds
Cheese.....	10.	pounds

Total..... 100. pounds

The following table shows what becomes of the various ingredients of milk in butter and cheese making. The left hand column shows the pounds of each ingredient in 100 pounds of average milk ; by following the line to the right of the name of each ingredient will be found what becomes of that ingredient when the milk is made into either butter or cheese :

DISTRIBUTION OF INGREDIENTS IN BUTTER AND CHEESE MAKING.

	Whole Milk Pounds	Skim Milk Pounds	Butter Milk Pounds	Butter Pounds	Whey Pounds	Cheese Pounds
Water.....	87.	72.2	14.18	.62	83.67	3.33
Fat.....	4	.24	.08	3.68	.45	3.55
Casein.....	2.6	2.2	.38	.02	.14	2.46
Albumen.....	.7	.6	.09	.01	.7	.....
Milk Sugar.....	4.95	4.12	.83	.....	4.5	.45
Mineral Matter.....	.75	.64	.11	.....	.54	.21
Totals.....	100.00	80.00	15.67	4.33	90.00	10.00

To illustrate the use of the above table let us consider what becomes of the fat in 100 pounds of milk.

The table shows that of the four pounds of fat in the milk, .24 pounds go into the skim-milk, .08 pounds into the butter-milk, and 3.68 pounds into the butter ; or, if cheese is made instead of butter, .45 pounds of fat go into the whey, and 3.55 pounds into the cheese.

It will be noticed that the totals under columns headed Butter, Butter-milk and Skim-milk, when added together, give 100 pounds, the weight of the whole milk ; the totals under the last two columns, or the whey and cheese columns, give the same.

Relation Between Butter-fat and Butter.

In the above table it is seen that, although there is a loss of fat in both skim-milk and butter-milk, the 4 pounds of fat originally in the milk yields 4.33 pounds of butter. The reason for this is plain when it is remembered that average butter is only 85 per cent. of fat, the remainder being water, casein and albumen. At the same rate 100 pounds of fat would yield $108\frac{1}{3}$ pounds of butter, and this is about the average result in creameries generally.

If the fat should yield at the same rate, and none were lost in skimming and churning, 100 pounds would make $117\frac{2}{3}$ pounds of butter.

When butter is made under ordinary farm conditions the loss of fat in both skimming and churning is very much greater than the above.

List of Dealers in Creamery and Dairy Supplies.

Creamery Package Mfg. Co.....	Chicago, Illinois
Cornish, Curtis & Greene Mfg. Co., Fort Akinson, Wis., and St. Paul, Minn	
Haney & Campbell Mfg. Co.....	Dubuque, Iowa
D. F. Barclay.....	Elgin, Illinois
F. B. Fargo & Co.....	Lake Mills, Wis

Advertisements of others may be found in dairy papers.

Get the catalogues issued by one or two of these firms and keep posted on prices.

WASHINGTON STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE

EXPERIMENT STATION

PULLMAN, WASHINGTON

BULLETIN 19

All bulletins of this station sent free to citizens of the state
on application to the Director.

DEPARTMENT OF HORTICULTURE VEGETABLES

NOTES ON THE CROPS OF 1895

By J. A. Balmer

1896

THE AGRICULTURAL EXPERIMENT STATION.

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VEGETABLES

By J. A. BALMER

The plot of ground containing about four acres, set aside for the cultivation of vegetables, is by no means a typical garden spot.

The contour of the land is such that a part of the ground faces the northeast, and a part the southwest, with a ridge or hog-back, running diagonally, and sloping from southeast to northwest.

SOIL.

The soil is peculiar to the Palouse valley where the experiment station is situated; it can hardly be called a loam, nor is it a clay, yet it partakes somewhat of the nature of each. There is not a grain of sand in its composition, yet it is easily worked when the moisture conditions are right. It is a retentive soil, packs close and water percolates through it very slowly, is rich in the necessary mineral matter, but lacks humus. It overlies a basalt formation. It is a soil that requires barnyard manure to improve its mechanical conditions.

There is an impression abroad that virgin soil contains all the elements necessary to the production of bountiful crops. This is not always the case however, for probably the poorest land we have on the station for vegetable gardening is that most recently reclaimed from the bunch grass waste. The vegetables this season were grown on land that has been in cultivation for several years but has never been manured except in spots for special purposes.

The climatic conditions the past season were such that it left us a very short and dry growing season.

On the northeast slope where our hotbeds are situated, the frost was not out of the ground nor the soil dry enough to work until the last week in March, consequently our hotbeds were not made, and seeds sown before the first week in April.

The bulk of seeds were sown in the open ground after the 20th of April, and as the first killing frost fell this year on the 3d of September, it left us less than four and a half months in which to produce the most of our garden crops. It is a waste of time and seed to try and force the season in this soil, for until the weather becomes settled, and the soil warm, crops do no good.

We made no difference in the time of planting early or late cabbage, and our ruta bagas were sown the same day as the early white varieties of turnips. This is rendered necessary owing to the scanty rain-fall during the summer months. Seed sown after the dry weather sets in do not always germinate. Peas sown the past season on July 15th did not come up until the fall rains came in September. These conditions leave us no scope for rotation of garden crops.

We have determined a few things pretty conclusively the past season.

It is a waste of time and money to attempt to raise such plants as Watermelons, Muskmelons, Peppers, Egg Plant, and even Tomatoes in the Palouse region.

A patch of Tomatoes was planted from seed that was sown in the greenhouse March 20th. The plants were first transplanted into flats, later they were potted, and finally transplanted into boxes and hardened off. When planted out they were strong, stocky plants, showing bloom buds. Even with this treatment the fruit on the earlier varieties was just commencing to color when the frost overtook them.

Squash, though nipped a little by the late frosts in spring, made a good showing. The plants grew well and set fruit abundantly.

The complaint usually made in new countries of a lack of insects to pollinate the flowers, certainly does not hold good in this part of Washington. There is an abundance of bumble bees, and wild bees are innumerable, besides the honey bees kept on the college grounds, and every pistillate flower seemed to set its fruit.

The season was not long enough to ripen the varieties we call "winter squash," but for the summer varieties, such as the Marrows, the climate is well adapted.

Onions grown from seed sown April 23d made a splendid crop, but the bulbs did not mature before the fall rains came, which

induced a second growth. As a consequence most of the Onions were thick-necked and did not keep well.

Peas, garden varieties, do exceedingly well here, the conditions seem about right for producing seed of the finest quality. Sown in spring when there is plenty of moisture in the ground, a cool climate to ripen the crop slowly, allowing the vine to bloom fully, and a perfect season in which to harvest the crop, and very little weevil. It seems to us it would pay seed growers to turn their attention to this part of Washington for the production of this particular crop.

Beans, too, of the earlier kind of wax and white Beans, are a successful crop.

Most kinds of roots do very well. Beets, Carrots, Turnips and Parsnips all produce remarkable crops.

Potatoes do exceedingly well on the cool north hill sides. Among the 45 varieties grown here this year there was not a single case of scab, and the Colorado beetle is unknown here.

Cabbage, Cauliflower and Celery require more moisture than we had the past season for the best results.

It must be distinctly understood that these remarks apply only to parts of Eastern Washington where the altitude (2,500 feet) is similar to that of the Experiment Station at Pullman. As a rule, in Eastern Washington the lower the altitude the longer the season, and a warmer climate. In the Snake River valley, which is 16 miles distant from Pullman, their strawberries are ripe before ours are in bloom, but they are 2,000 feet lower. There they can ripen Black Hamburg and Muscat of Alexandria Grapes, while it is somewhat doubtful if we up here can produce a bunch of thoroughly ripened Grapes even on the hardiest variety. There are valleys, like the Walla Walla and Yakima, where the season is long enough to produce the tenderer vegetables and melons in perfection, and to such parts of Washington these remarks will not apply.

In a part of the country where the seasons are as variable as they are here, it cannot be expected that we can determine the merits or demerits, or point out with accuracy the usefulness of a particular variety from one season's trial. In 1894 the first killing frost fell on October 3rd, just one month later than in 1895, giving a month longer season for the growth of tender vegetation.

With a growing season of the same duration in 1895, as in 1894, we would without a doubt have had ripe Squash, a crop of Tomatoes, and maybe some Cucumbers. So we feel that to give the results of this season's work and call it final, would be all wrong. Further trial is necessary. Notes taken this season will be valuable for later reports.

The remarks on the varieties which follow may be regarded as preliminary.

CABBAGE.

Nineteen varieties were grown, about equally divided between early, medium and late. The seed of all varieties was sown in a gentle hotbed on April 15th, and planted out May 24th. Each variety occupied a row 200 feet long, and all were subject to the same conditions. The soil was in good condition as regards tilth and moisture, but was not rich enough for the best results with cabbage. It is a safe rule to use plenty manure on all garden crops that are grown for their foliage, and it is almost impossible to make land too rich for the Brassica family.

The varieties planted were: Luxemburg, Hollander, Stien Early Flat Dutch, Henderson's Succession, Fottlers Improved Brunswick, Early Winningstadt, Early Jersey Wakefield, Improved Early Summer, Fine Large Flat Dutch (American seed), Fine Large Flat Dutch (imported seed), Extra Early Express, Early York, Improved Stone Head, Heavy Red Dutch, All Seasons, Large Late Drumhead, American Drumhead, Green Glazed, Mammoth Rock Red, and Summer Savoy.

All made satisfactory growth in the early part of the season. The first to mature was Extra Early Express, ready July 11th, eighty days from the seed, and fifty-two days after being planted out. It is a small, heart-shaped cabbage, sure header and moderately solid.

Early York, and Early Jersey Wakefield were four or five days later. The Early York is smaller and inferior to the Early Jersey Wakefield, and where the latter is grown, Early York has no place.

Early Winningstadt was the next to mature, about a week later than the two last mentioned, and is by all odds the best early heart-shaped cabbage for the farmer or cottager to grow in

this section of the country. It is larger than the other early varieties mentioned, and has the good quality of keeping a long time after it is mature or headed. In an ordinary season it will keep well into the fall without bolting. It was a good cabbage the past season long after the three varieties mentioned before it had run to seed.

Of the summer varieties, Improved Early Summer, and Henderson's Succession can be recommended. Both are cabbage containing a large per cent. of Flat Dutch blood, and are somewhat coarser in texture than the heart-shaped varieties; they keep well into the fall and may be used for early kraut.

Amongst the late or winter cabbage, Large Late Drumhead made by far the best showing. A fine, large head, distinct, and of good quality, few outer leaves and a short stem.

In the other late kinds, Luxemburg, Hollander, Stein Early Flat Dutch, Fottler's Improved Brunswick and the two Flat Dutch varieties, I fail to see any distinguishing characteristics, and am of the opinion we have too many of this Flat Dutch tribe.

The Green Glazed cabbage mentioned in this collection, is of little utility, but is quite ornamental.

During the month of August, when not a drop of rain fell, all varieties of cabbage seemed to suffer; we have no means of irrigating and rely entirely on the rainfall.

The cabbage aphid, (*Aphis Brassica*) appeared in great numbers during the drouth, but the crop was too far advanced to be much affected by them. When a few liberal showers fell during the early part of September, the cabbage were stimulated to a new growth, and the consequence was numerous bursted heads. Fully one-half of the late varieties were lost owing to this defect. All sound heads were harvested on the 10th and 11th of November and placed in a root cellar. The red varieties were placed by themselves to be used for making pickles.

TO KEEP CABBAGE IN WINTER.

Care must be taken to avoid heating. Don't put cabbage in large piles, nor many in a pit.

If the soil be sandy and porous, pull the cabbage at the approach of winter, and turn them upside down upon the level

ground in rows two or three deep. As the winter advances cover slightly with soil, or trim off outer leaves and remove to a cool cellar and lay thinly on the floor, or on shelves, or hang them up to the roof. Some people prefer to bury them in pits like potatoes. This answers very well if few are put in a pit to avoid heating. In keeping cabbage a dry atmosphere ought to be avoided or the cabbage will shrivel.

ONIONS.

On the 22d of April twenty-two varieties of onions were sown, one row of each, 200 feet long. The ground was plowed, dragged and harrowed, and presented a very even surface. No manure or other fertilizer was used. The seed was all from one seedsman, J. M. Thorburn & Co., New York, and proved fresh, as all varieties germinated well. The kinds sown were, Yellow Globe Spanish, Yellow Globe, Flat Maderia, White Flat Bermuda, Giant White Garganus, Yellow Globe Denvers, Giant White Tripoli, Red Bermuda, English White Pickling, Thorburn's Excelsior White Pickling, Yellow Danvers, Mammoth Red Garganus, Globe Maderia, Giant Rocca Red, Giant Rocca Yellow, Red Globe, Large Red Weathersfield, Yellow Strasburg, Early Red Flat, New Gigantic Gibraltar, Egyptian and White Barletta. With the exception of the two pickling varieties and the Egyptian, none of the onions were ripe at the time they were pulled, October 19th.

An onion may be said to be ripe when the top falls over, and the bulb is well developed. Most varieties grew well and formed good-sized bulbs, but there was a very large per cent. of "thick necks" amongst them. This feature was not confined to any particular variety, for all the kinds planted were affected by it, for fully sixty per cent. of all bulbs lifted were "thick necks." All through the dry season there was no wilting or stoppage of growth, but there was evident stimulation to extra growth when the fall rains came. At the time of pulling we had no opportunity to harvest them properly, by drying them on the ground in the sunshine. The nights were quite frosty, and the soil cool and damp, so inside drying had to be resorted to. We do not consider the trial a satisfactory one, and the coming season will try a different method.

What is known as "the New Onion culture" may answer here. This is simply to sow the seed in a gentle hotbed early enough in the season, so that at the earliest moment the ground can be worked, the young onions may be planted out, i. e., transplanted from the hotbed to the open ground. This is in reality no extra work, for one can plant a row of onions more quickly than he can thin the same row, and moreover it is a saving of seed.

Notes were taken this season on the habit of growth, size and shape of bulb, and each variety was weighed at the time of lifting.

Flat Maderia, Yellow Globe Denvers, Mammoth Red Garganus, Giant Rocco Yellow, Yellow Strasburg, and Large Red Weathersfield gave the best results in size, quality and productiveness.

Red Globe, from the fact that it ripens early and yields a uniform, medium-sized bulb, is a good onion to grow for family use in this upper country.

Of the pickling varieties, English White made the most uniform, small white bulbs.

Egyptian, a new variety, is too small to find a place amongst good onions.

PEAS.

Bulletin 10 of this station gives results of a varietal test of peas, twenty-six varieties being described. Six new varieties were grown the past season. None of them have been reported on before from this station.

Two varieties, Renown and Echo, were sent in by W. Atlee Burpee & Co., Philadelphia, Pa.

Four varieties came from the Agricultural Department, Washington, D. C.

Renown.—This new variety is a late season pea with a large pod containing nine or ten peas, grows a long vine and needs staking. It promises well and will be tried further.

Echo.—Pod large to very large, slow to fill, and very late, is valuable on this account; straw long, not such a good producer as Renown. A good pea.

Dwarf Champion.—This is probably only a half dwarf, pro-

duces well, pods larger than is usual on dwarfs; six to eight peas in a pod. Mid-season.

Melting Sugar.—A wrinkled pea, very much resembles Henderson's Midsummer, moderately productive.

Bishop's Long Podded.—This pea was very late, with a large pod that does not fill well; sown the same date as the others, April 23. It remained green and fit for table longer than any pea we grew this season.

Sterling.—A pea of no particular merit; comes in at mid-season when lots of good peas are ready.

CAULIFLOWER AND BROCCOLI.

To the ordinary observer, there is no greater difference between a cauliflower and a broccoli than between a plum and a prune. Botanists disagree about the origin of these two forms, some claim the same ancestry for both, while others refer them to two distinct species. For all practical purposes they might well bear the same name. Old gardeners recognize the broccoli as a fall or winter variety of cauliflower. In our day we have early and late broccoli as well as cauliflower. Of all the crops a gardner grows none respond so quickly to liberal treatment as do cauliflower. To grow good cauliflower it is absolutely necessary that the ground be rich, deep and moist, and if the plants can be shaded from the hot noonday sun it will be a benefit. Out of ten varieties of cauliflower and broccoli grown on the station this year, only one was a complete failure, viz., the Early Purple Cape; it is a poor color for market and with us bolted into bloom without forming heads. The White Cape Broccoli also went largely to seed without forming heads; both these varieties probably require a cooler, moister climate than we have here. Of the other varieties, Large Early London, Burpee's Best Early, Walcheren, Thorburn's Gilt Edge, Veitches' Autumn Giant, Thorburn's Extra Early Dwarf, Large Algiers, Thorburn's Nonpareil.

The honors are evenly divided between Thorburn's Gilt Edge and Burpee's Best Early. The field notes taken of the former variety read: Remarkably good, medium early, dwarf, fine heads, solid, close grained, pure white.

The description of Burpee's best early is very good; dwarf and flat, dense head, and though somewhat flaring it retains its pure

white color even when exposed to the bright sunrays. The season was too short for Veitches' autumn giant, and Walcheren.

London early and large Algiers produced some fine heads. The season was altogether too dry for the best results with cauliflower. With the right soil conditions and a little more rainfall, we can without a doubt produce fine cauliflower here.

CELERY.

Ten varieties were sown in hotbeds about the middle of April, composed of tall, dwarf, and white plumed kinds. They made very slow progress, and in due time were planted out in trenches, two rows in a trench. The ground was very dry at time of planting, and remained so except that the plants were thoroughly watered after setting. A couple of hundred plants were within reach of a hose attached to a half inch pipe, and these were sprinkled frequently. The bulk of plants got no water after planting and every plant outside of the water line died inside of four weeks from the time of planting. The plants that received water grew very slowly, and in the fall when celery ought to be ready to receive its last earthing, the best plants were about fifteen inches high, and of course not good for market. People who attempt to grow celery should remember that the plant is a semi-aquatic, consequently requires much water, and being a gross feeder needs a liberal supply of manure.

A great deal of our best celery has been sacrificed by growing the white plumed self-bleaching sorts, to the neglect of better varieties that require more work. To have celery of the finest quality, tender and crisp, and of fine nutty flavor, it must be bleached in contact with the earth. The white foliage kinds are as a rule flavorless and pithy.

SUGAR CORN.

Six varieties were planted on April 24th, one quart of seed of each, rows four feet apart, hills thirty inches apart. The varieties were: Country Gentleman, Early Marblehead, Early Eight-rowed, Stowell's Evergreen, Early Adams, Moor's Early Concord. Of these six varieties, not one produced an ear of corn fit for the table except Stowell's Evergreen, and it produced about one-fourth of a crop of very inferior ears.

From the above we gather that sweet corn will succeed here only when the season is favorable.

In 1894 some of these same varieties sown a week later than in 1895 produced a full crop of fine roasting ears, and even ripened seed. But the seasons were very dissimilar. Frequent showers and warm weather early in the season of 1894 made it a superior growing season.

LIMA BEANS

Were almost a total failure; they did not grow tall enough to need poles, and few of the vines produced pods. Two varieties were grown, Dreer's Lima and Early Jersey Lima. We may expect a more favorable season sometime, and will try them again. Lima Beans belong to warmer countries and are not in their element this far north. Many kinds of beans do well here. A great variety is grown in the United States; the larger portion of them belongs to the family commonly known as wax or French kidney beans, often called Bush beans. Our commercial varieties, those sold in a dry state and used as a vegetable, such as the Navy, small white, Bayo, and others, generally belong to the Haricot or common kidney bean.

In the vicinity of Pullman a considerable acreage is devoted to the cultivation of these dry beans. In a favorable season the profits from an acre of white beans is quite large as compared with wheat. A small package each of four varieties of these commercial beans were sent to the Station the past spring by Duttard, of San Francisco. These were Pinks, Lady Washington, Bayo and small whites. All were sown in the garden the last week in April, and each variety ripened its seed perfectly. Experiments on a large scale will be carried out with these commercial varieties to determine productiveness, adaptability, etc.

The wax, or snap, beans are a great success here, producing large quantities of pods that retain their tenderness for a considerable period.

The Broad Bean (*Faba vulgaris*), sometimes called English Broad Bean, does very well here. A short row of this variety the past season produced a quantity of well filled pods. In eating this bean only the seed is used. Shell like peas when the pods are well filled, and boil like peas. It is a very desirable vegetable.

CARDOON

Cardoon.—*Cynara Carduneulus* probably does not differ from the Globe Artichoke, *Cynara Scholymus* of botanists. A silvery, gray-colored plant with much divided leaves, which in their young stage are tied in bunches on the growing plant until the leaves on the inside are blanched. They are then used as salad under the name of Cardoon. The same plant allowed to flower is called Globe Artichoke, and the base of the fleshy scales covering the unopened flower are used as a vegetable. It grows well here. To get the best results, Globe Artichokes ought to be banked round with manure in the fall. This is for protection as well as to stimulate the plant. For salad, it is best to sow the seed each spring.

LENTIL.

A quart of seed was planted, which made a satisfactory growth and produced an abundance of seed. We do not seem to have much use for this old vegetable in our day. Beans, peas, rice and other dried vegetables have driven the Lentil to the wall.

BEETS

Are a good crop here, though the severe drouth of the past summer influenced the size of the roots. Five varieties of garden beet and seven varieties of sugar beet were grown on the trial grounds. The garden varieties were: Early Blood Turnip, Extra Early Dark Egyptian, Dark Stinson, Dewing's Blood Turnip, Crosby's Egyptian.

The criterion of a good garden beet is not size and quantity, but color, earliness and table qualities.

Extra Early Dark Egyptian was first ready. The roots are of fair size, good color and a very small top. Consequently, it can be grown closer than some varieties.

Crosby's Egyptian (U. S. G.)—Not quite so early as the preceding variety, but gives a large root, of good quality and has all the marks of a good beet.

Dark Stinson.—A small trial package of seed from Burpee, produced a few nice roots and is worthy of further trial. All garden varieties of beet were grown in rows four feet apart and cultivated by horse.

SUGAR BEETS

Were planted in rows twenty inches apart and cultivated by hand. Owing to the dry weather the roots on sugar beets were very small this season, too small for the best results as sugar producers. Previous experiments with sugar beets on the same grounds have yielded very satisfactory results.

SPINACH.

Two varieties were grown, Round Flanders and New Zealand. The latter a very distinct variety. It grew through the hot, dry summer without showing signs of going to seed, a very desirable quality. It is somewhat inferior in table qualities to the round varieties. Round Flanders had run to seed by the middle of July.

CARROTS

Thrive best in a rich sandy loam, though almost any good soil will grow carrots profitably. As a rule, the stump-rooted or half-long kinds are most sought after for culinary purposes, while the long, gross growing carrots are usually fed to stock. The garden varieties have usually a smaller core and are less woody in texture.

A few varieties of each kind were grown, viz., Mastodon, Parisian Button, Saint Valery, Improved Luc, Improved Long Orange, Yellow Belgin, New Forcing, Half Long Chantenay, Carentan, Denver's New Half Long Luc.

Among the garden varieties Carentan, a kind that is practically coreless, flesh red, and of fine quality, roots uniform and a good croper, gave the best results, 425 pounds of roots from one ounce of seed.

Half Long Chantenay was a good second with 403 pounds of roots. It was rather surprising to find these half-long carrots yielded a greater weight of roots than the long, deep-rooting kinds usually grown for stock. This may be mainly owing to the fact that in digging the long roots, a portion of the root is often left in the ground.

Further experiments will be carried out along this line, to determine which are most profitable to grow.

Of the big carrots, Improved Long Orange (Henderson), gave the greatest yield.

TURNIPS.

Only a few varieties were grown, some kinds stood the drouth of summer better than others. The earlier kinds retained their tenderness late into summer and grew to a large size. There was almost a total absence of the little black flea beetle the past spring. A fungus growth or mildew affected the late varieties. The kinds grown were Long White Tankard, Gray Stone, Laing's Purple Top Ruta Baga, Early Flat Dutch, Early Snowball, New Kashmyr (Burpee), Long White French.

Early Snowball was first ready for use, and remained tender well into summer.

Of the late kinds Long White Tankard is a good turnip, it stood the drouth well and was a good turnip in the kitchen at the end of October. The Ruta Bagas lost most of their foliage during the drouth, but made a new growth after the fall rains came. This second growth injured the quality of the roots.

OKRA

Was a complete failure here. It requires more heat and a longer season. Three varieties were planted, New Dwarf Density, White velvet and Ladies Finger. The best growth on any variety was nine inches, and one pod the most any plant bore.

LEEK

This pot vegetable which belongs to the same family as the onion, requires a cool, moist, rich soil. The one variety planted here the past season made a good growth and is suited to the climate. The blanched part of the plant, that portion found below the surface of the ground, is used in soups.

KOHL RABI

Is quite satisfactory here—sometimes called turnip rooted cabbage, from the fact that it partakes somewhat of the nature of each in form and flavor. A short row yielded some good bulbs.

RADISH.

The early season varieties, both turnip-rooted and long kinds, are very satisfactory here, the roots retaining their crispness over an extended season. On the contrary, the large rooted winter varieties were almost a total failure, giving very poor results.

As our garden ground becomes better prepared and fitted to grow vegetables of the highest order, these crops will be tried again.

RHUBARB.

The seed of three varieties was sown, but not a plant appeared. The usual method of getting a start of this vegetable is to buy the roots, which are easily divided and bear transplanting well. It needs a cool, moist situation and heavy top-dressing annually with cow manure.

PARSLEY

Does remarkably well here, growing through the dry season and producing large quantities of its beautiful curled foliage. A patch ought to be sown every year, as the plant is a biennial, *i. e.*, goes to seed the second year and dies.

CHICKORY

Is a very satisfactory crop here. A short row of it produced many large roots. It is possible that this will be a profitable crop in many parts of Washington.

Of the many herbs sown here the past season, Dandelion, Sage, Coriander, Saffron and Tansy, all made good growth. Many varieties did not germinate, probably owing to the poor quality of the seed. These will be tried again.

SQUASH.

Fourteen varieties were planted on a north hill side in good soil. Each variety occupied a row 60 feet long, rows 6 feet apart, and hills from 4 to 7 feet, according to the habit of the plant. The seed was planted the last week in April, and without exception came up well. A frost on the 22d of May nipped the tender foliage of some varieties, but did little damage. They grew rapidly and soon covered the ground. Those planted were, White Bush Scalloped, Valparaiso, Early Prolific Marrow, Low Bay State, Low Bush Summer Crooknecked, Fordhook, Butman, Coconut, Boston Marrow, Mammoth Bush Summer, Perfect Gem, Extra Early Orange Marrow, Pike's Peak and Silver Custard. The growing season was too short for the class we call "Winter Squash." After the first killing frost in the fall the fruit was gathered and carried to a dry cellar. Within a month decay had

set in on all varieties except Pikes Peak, a few of which kept several weeks later. Extra Early Orange Marrow was first ready for use. The varieties Boston Marrow and Early Prolific Marrow seemed to us identical. The Marrows, as a rule, make large vines, and are best for table when quite young.

The bush varieties occupy less room in the garden than the marrows, and as most of them are quite prolific, we would recommend them for small gardens.

BRUSSELS SPROUTS.

This is one of the *Brassica* family, filling a place at a season of the year when green vegetables are at a premium. It is a late fall and winter vegetable. Minature cabbages grow on a stalk with a tuft of leaves on top. In severe weather these top tufts hang down over the little cabbages on the stalk and protect them from the weather. A very desirable vegetable that ought to be more largely grown. It promises to do well here.

LETTUCE

Was largely grown, mostly from home-saved seed. In the greenhouse, where the early crops were grown, Black Seeded Simpson made the best showing. It is a crinkley foliaged variety, and does not heart readily, but makes a great amount of leaves and is of good quality. For summer use, the varieties that head like cabbage will be found the most desirable. A variety named Market Gardner's Private Stock (Thorburn), stood the summer's sun a long time before bursting, and in this respect was the best variety we grew.

TOMATOES.

This experiment was carried out under unfavorable climatic conditions, and gives no clew to the merits of the varieties under test. Fifteen varieties were planted on a southern exposure. The plants were started in the greenhouse at two sowings, one March 20th and another April 4th. The plants were transplanted three times before putting them outside, and were in excellent condition; they had not been allowed to become woody. After planting, there came a succession of cold winds, which terminated in a sharp frost (the same that injured the squash), which checked their growth considerably. The varieties were: Golden Sunrise,

Livingston's Beauty, Optimus, Tree, Ignatum, Livingston's Favorite, Yellow Cherry, Yellow Plum, Queen, Trophy, New Peach, Peach, The Shah, Ponderosa, Fordhook. Fifteen plants of each variety were used, and all planted the same day, May 13th. The growth was satisfactory, though slow, and all varieties set fruit very heavily. The frost that fell September 3d, stopped all growth, just as the fruit on the earlier kinds was commencing to color.

Golden Sunrise has all the qualities of the best red kinds; is large, of a golden yellow color, and nice size for slicing. This variety and Ignatum were first to ripen. The small yellow varieties, Yellow Cherry and Yellow Plum, produced large quantities of small-sized fruit, suitable for making preserves.

Water Melons, Musk Melons and Egg Plants, were given a trial on a favored exposure. They made very poor growth and the frost caught them before the fruit was half grown. Our climate is too cold and seasons too short to successfully grow this class of plant.

TOBACCO

Was tried on a plot of ground near the greenhouse. The growth was slow and the leaves short and were badly eaten by grasshoppers.

POTATOES.

An experiment is commenced with potatoes and will continue three seasons. The past year we planted forty-five varieties, ten pounds of seed of each, all cut to two eyes. Notes were taken on the growth, time of ripening, table qualities, etc., and each variety was weighed at the time of lifting, and also after the small potatoes had been separated from the larger ones. The yield was excellent, averaging twenty-five pounds of tubers for every pound of seed planted. As this experiment will be the subject of a special bulletin we will not go into details at present.

CARE OF THE GARDEN

A few years ago, the late Peter Henderson in his work, "Gardening for Profit," strongly advocated the use of the feet in firming the soil after planting seed. This practice is very generally followed today, and was before Mr. Henderson's day, by old Scotch gardeners, and on light, sandy, porous soils, it is an excellent plan to practice. On the soil at Pullman, this tramping with the feet gives the reverse of good results. On rows of peas where we had tramped carefully, it was found that the soil had become baked into hard lumps, and all during the season, whenever the cultivator got too near a row of plants, it was likely to tear up a chunk of soil, bringing with it a section of the row of plants, while the soil between the rows was in a mellow condition. The soil at planting time was not wet—just moist. We are convinced the practice of tramping in seeds is wrong, as far as the soil on the station is concerned, and will discontinue it.

Vegetable gardens had better be plowed in the fall. Of course this refers to ground already cleared of its crop. There is no agent known equal to frost as a meliorator of the soil, and to take full advantage of this, gardens ought to be plowed or spaded up in the fall, and the land left with as rough a surface as possible; the idea is to expose the greatest surface to the elements. The action of the frost is to disintegrate, to break up and let loose particles of matter which soon become available as plant food. I would sooner have a piece of land plowed in the fall and left to the winter elements, than the same land plowed in spring for purposes of gardening. Land that has been plowed in the fall and left as rough as possible will be found to break down easily to a fine surface, and be in condition to plant several days before land that is plowed in the spring. For all vegetable crops grown for their foliage, like lettuce, cabbage, spinach, etc., land cannot well be too rich.

Peas, beans, and some kinds of roots may be grown well with less manure. Vegetables of the finest quality, quickly grown,

crisp, tender, and juicy, cannot be produced without large quantities of fertilizer, and there is none better than partially decomposed barn yard manure.

CULTIVATION.

As soon as the crops are visible in early summer, the cultivator ought to commence to run, and be continued every ten days or two weeks until the crop is matured.

On soils that have a tendency to bake, the cultivator ought to run through after every shower, also after irrigating.

WASHINGTON STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE

EXPERIMENT STATION

PULLMAN, WASHINGTON

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FIBRE FLAX IN WASHINGTON

By Dr. A. W. Thornton

Special Agent for the Investigation of Fibre Flax

1896

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FIBRE FLAX IN WASHINGTON

By Dr. A. W. THORNTON

Flax culture, owing to the distinctive character of the Flax plant, and the different purposes to which its products are applied, requires important modifications that the general farmer is unfamiliar with. This Bulletin is, therefore, intended to set forth in plain language simple instructions that will enable the ordinary farmer to grow Flax intelligently and successfully. I will, therefore, in order to condense the subject to strictly cultural instructions, refrain at this time from any consideration of a number of interesting technical details, which would extend this Bulletin beyond the limits at my disposal. As, however, in this State we have citizens from flax-growing sections of Europe who are familiar with the practice adopted in their own country for the culture and preparation of Flax, and as the practice differs greatly in material details in Ireland, Belgium, Holland, Prussia, Russia, France, and among the Scandinavians—all differ more or less, while each considers his own practice the best, and not only so, but that the others are all wrong!—I cannot hope, nor will I endeavor to escape cavil and adverse criticism, merely stating broadly that the local conditions in this portion of the United States are so different from those existing in Europe, that an entirely different system of practice is required, and we require, *not to Europeanize the American, but to Americanize the European system*, and for that purpose this Bulletin is prepared.

The first thing that will strike the observant farmer in examining the Flax plant and observing its habit of growth, is that unlike Wheat, Oats, or any of the grasses, which develop a vast number of fine fibrous roots near the surface, from whence they derive their nourishment, the Flax plant sends down to the subsoil a single long tap root, with only a few very fine fibres, and instead of stooling out, sends up only one long, straight stem, branching out only after attaining a considerable height. This preliminary observation furnishes us with a clue, by which we are enabled to regulate our management of the crop with intelligence and success. Having attained a knowledge of the habit of growth of the plant, it becomes necessary to inform ourselves of its requirements, and then of the uses for which it is required.

The requirements of the Flax plant are a moderately fertile soil—such as will produce good grain crops—a cool, moist, equable climate; a deep, clean, well tilled seed bed, with early sowing, and while it requires about the same amount of plant food that a fair crop of Wheat will, yet as it takes

its nourishment from a deeper strata of the soil than the Wheat crop, it does *not* exhaust the land, as is generally supposed, in the same manner as grain does, if (mark that if) *the habits of the plant are fairly met*. This statement is, I am aware, apparently contrary to the experience of Flax growers, and open to criticism; but as the arguments in support of it would take up too much space in this Bulletin, I will merely state, as a matter of fact, that recent scientific examinations have established the correctness of this statement, although of such recent date that they have not yet become generally known and accredited, especially by that class of Flax farmers who think "they know it all!" It is a matter of experience in Europe, as illustrating this point, that when a farmer is short of fertilizers for his Flax crop he will plow his land ten or twelve inches deep in the fall, again plow shallower in the spring, cultivate, harrow and roll, till the land is as fine as an onion bed, sow Flax and have a fine crop; and follow it with Wheat in the fall, without fertilizer, and harvest from 45 to 60 bushels of Wheat per acre. Now, if Flax was the exhaustive crop some superficial observers would have it, such a result could not be obtained. If, however, Flax is sown thinly, in shallow, ill-cultivated ground, with plenty of weeds, any land would soon be exhausted.

This idea of the exhaustive nature of Flax has also been corroborated by the fact that Flax cannot be grown successfully in immediate succession to Flax on the same land, and it is necessary to allow an interval of several years between two successive crops of Flax. This corroboration is only apparent, however, as has been shown by Mr. Otto Lugger, of the Minnesota Experiment Station, in a very complete series of experiments, an account of which is published in Bulletin No. 40 of the Minnesota Experiment Station. The details of Mr. Lugger's investigations are most instructive, interesting and original. I regret they are too extended to quote in this place. However, they prove conclusively that this peculiarity of one crop of Flax, being inimicable to another immediately succeeding it, does not arise from either soil exhaustion or bacteria, but from the fact that the debris of the crop left on the land—leaves, roots, straw, etc.—develops a principle poisonous to Flax, though not injurious to any other crop.

A still more important factor in modifying the cultural treatment of Flax depends upon the uses to which the product is to be applied, and may be resolved into four, each requiring a distinct modification in the treatment of the crop.

First—The growing of Flax solely for the seed for manufacturing into oil is adapted to hot, dry climates, with unobstructed prairie openings, where cultivation can be carried out with improved labor-saving machinery and upon extended areas, as practiced in the Western States, and at the lowest possible cost. In this case the seed is sown thinly to encourage branching, and a yield of about 10 to 15 bushels per acre may be expected. In this case the straw is ignored, burned or fed to stock, or sold at a low price for indurated fibre ware, etc.

Second—The growing of Flax for seed for again sowing for fibre. This

practice is adapted to the delta lands on Puget Sound and Western Washington, and requires a thicker sowing ($1\frac{1}{2}$ to 2 bushels per acre) in order to strengthen and intensify the habit of growing up in a long stalk, with only a few branches at the very top of the plant. In both these cases it is necessary to allow the seed to ripen fully, and the harvesting may be done with an ordinary self-binder, the knives being kept sharp. It being a very important matter to those growing Flax for fibre to have the seed saved from what might be called pedigree Flax, with a confirmed habit of tall growth, consequently American Flax seed as grown for the oil mills is entirely unfitted for fibre culture. At present the seed for that purpose requires to be imported from Russia, Holland or Belgium, and consequently a material difference in price will be offered for the two qualities of seed, the ordinary seed for the oil mills being worth about \$1 to \$1.25 per bushel, while seed for fibre purposes will be worth \$2 and upwards. The yield of Flax seed of this quality on Puget Sound—where seed equal to the European can be grown—will be from 15 to 25 bushels per acre.

Third—Growing of Flax for fibre and saving the seed also, requires sowing with $1\frac{1}{2}$ to $2\frac{1}{2}$ bushels of seed per acre, and *pulling* the straw when the seed is in the dough stage. This is really more profitable than either of the two former systems. Under this system the yield will be from $2\frac{1}{2}$ to 4 tons of straw per acre, worth from \$10 to \$20 per ton, and 15 to 20 bushels of seed, for the seed will ripen on the straw after it is pulled. This system, however, requires the establishment of scutching mills in the neighborhood to render it feasible.

Fourth—Growing of Flax for the finest grades of fibre is adapted to Puget Sound and Western Washington, and requires pulling in a greener condition than the last, and the fibre being so valuable that the saving of seed is of no consideration, the product will be 3 to 4 tons of straw per acre, worth on the farm from \$15 to \$25 per ton. This system requires heavy seeding, $2\frac{1}{2}$ to $3\frac{1}{2}$ bushels per acre, and is also dependent upon the establishment of scutching mills, as the farmer's work consists of growing and harvesting the Flax, while the subsequent work of retting, breaking and scutching to produce the raw fibre for the spinners and manufacturers is properly the work of the scutch mill owners. While it is quite possible for the farmer, if he has the necessary skill and experience, to ret and prepare the fibre for market by hand work at considerable profit to himself, yet he cannot, of course, successfully compete with the machine work of the scutch mills.

In fact, in more than one experiment I conducted on Puget Sound, with the resources only of an ordinary Puget Sound farm, I have produced by hand a grade of fibre worth 14 cents per pound in the Eastern and European market, and under other conditions could have produced a much more valuable grade of fibre with the same appliances. Such work might be duplicated one thousand times by our pioneer farmers by working up in spare hours a little crop of Flax, and thus largely increasing their income. For some years to come, however, the practice will be for the farmer to

grow the Flax and sell the straw and seed to the mill—the mill being either on the co-operative plan or proprietary.

I will now proceed to consider the various details of Flax culture.

SOIL.

Any reasonably fertile soil will grow Flax, though the quality of the fibre will be modified by the nature of the soil. I have had over sixty different farmers grow experimental crops of Flax for me on Puget Sound, upon every possible variety of soil, and the only ones entirely unsuited were newly broken raw peat and very light sandy land. This latter would, however, have produced a fair crop if sown early and in a moist season. A deep, sandy loam, with sufficient clay to give it strength without stiffness, with good natural drainage—failing which artificial drainage must be provided, as wet, soggy land is unsuitable for Flax. The uplands produce a finer quality of fibre than the black alluvial river deltas, though the rich bottom lands will produce large crops and seed of high quality, and if sown thickly and early will give a very long, straight stem, without branches.

PREPARATION OF SOIL.

For Flax, owing to its habit of sending down a long tap root to the sub-soil, a deep seed bed is required, and the land should be plowed ten or twelve inches deep in the fall. In land adapted to it, subsoiling will be found of great advantage, harrowing the land level after the fall plowing and leaving it for the winter rains to consolidate, as owing to the absence of fibrous roots the soil requires to be firmly compacted around the slender tap root below, while loose and friable on the surface. Then, as early in the spring as the ground is capable of being worked—in Western Washington from the middle of March to the middle of April—again plow shallow, about three or four inches, and harrow and work till a fine tilth is obtained, suitable for an onion bed, and if the land is of a light sandy nature, roll. At this stage, it will be well to wait a week or ten days to allow the weed seeds in the ground to start, and then harrow or cultivate thoroughly to smother the millions of weed seeds that may start to grow. For, remember that "*Weeds are death on Flax.*" No use trying to grow Flax on weedy or lumpy land. In Europe the men, women and children go down on their knees, sometimes two or three times, to hand pick the weeds, but this practice is contrary to the spirit of the American people, and in order to Americanize the European practice it is necessary to have our Flax land clean of weeds before sowing, which may be secured by careful tillage, or by using a two or three-year old clover sod or meadow, freshly broken in the fall.

SEED.

Ordinary American or Canadian seed, about three pecks to the acre, will answer for sowing, when the object is to supply the oil mills. But if intended for growing seed for sowing for fibre, imported Riga, Dutch or Belgian seed is necessary, or at least that quality of seed, acclimated by one season's planting in the United States; or, better still, Flax seed grown

on Puget Sound specially for fibre growing purposes. For it is an established fact that the oily seeds, such as cabbage and cauliflower, grown on Puget Sound are superior to any grown elsewhere, and the same holds good with Puget Sound grown Flax seed. It is also important to have clean, fresh and bright seed, and it will be found profitable in every case to re-clean Flax seed before sowing, as well as to test its germinating quality. So much depending upon the thickness of the seeding, it is important to know before hand the ratio of germinating to non-germinating seed, for the reason that if one calculates upon sowing thickly, say 3 bushels per acre, and the seed from any cause fails to germinate more than in two-thirds, he will only have the same result that he would secure by sowing only 2 bushels of good seed, thus disappointing his expectations. On the other hand, by testing his seed before sowing he would be enabled to secure the desired result by adding little more than one-third more seed to supply the loss. This seed testing is a simple matter, and may be effected by counting out 100 average seeds and placing between folds of moist cloth or flannel, upon an ordinary plate, and placing in a warm corner near the stove. This should be done one or two weeks before sowing time. In the course of two or three days the good seed will swell up and germinate, and by counting the seeds that sprout, the percentage of good to bad seed will be known, and allowance made accordingly. It is not necessary to carry the germinating further than the bursting of the husk and appearance of the germ or sprout.

The quantity of seed to be sown varies according to purpose in view. If for seed only for the oil mill, 3 pecks per acre will be sufficient, and may be sown either broadcast or with a drill. If for seed for sowing for fibre purposes, the seeding should not be less than $1\frac{1}{2}$ bushels (90 lbs) per acre, and may be increased with advantage to 2 bushels per acre, and should be sown broadcast, in order to intensify the habit of tall growth without branching.

If for fibre purpose, 2, $2\frac{1}{2}$, 3 and even $3\frac{1}{2}$ bushels per acre may be sown, and *must* be broadcasted, with great care, to have the crop uniform in thickness all through, as it is a very bad fault to have the straw uneven in length and fineness, and one that will call for docking in the price at the mill, for the reason that coarse straw rets more rapidly than fine, consequently if mixed a uniform ret cannot be obtained, and the quality of the fibre is injured thereby.

After sowing, the seed is lightly covered and rolled, and if the soil and season are favorable the seed will germinate in a few days, and in clean ground require no further treatment till harvested.

ROTATION OF CROPS.

In Flax culture the rotation of crops is a question of great importance, and cannot be laid down under any iron-clad rule. There are, however, fundamental principles that will guide the intelligent farmer and enable him to conform with his local conditions. The first is, "*Weeds are death on Flax*," consequently any system that will secure clean land before sow-

ing will meet this requirement; among which we may mention, deep plowing of clover sod or grass meadow, throwing the sod, by means of a jointer or skim plow, to the bottom of the furrow and covering it completely with the furrow slice, and again plowing shallow in the spring; or using ground that has been under hoed crops the previous season and *kept clean all the season*. Not as many hoed crops are worked with a cultivator two or three times in the early part of the season and left neglected for a late crop of weeds to become established. Also land that has been summer fallowed. By summer fallowed, I mean *summer fallowed*—not plowed and left all summer unworked, but plowed in the spring and then cultivated without a crop every few weeks all through the season, until in September or October not a live weed can be found in it. This is summer fallowing.

The next principal is, "*Flax must not succeed Flax on the same land.*" In Europe an interval of five, eight or ten years is allowed to elapse between two crops of Flax, but in our newer lands an interval of three or four will be perhaps sufficient. The European farmers divide their lands into definite plats, and go through a regular rotation. This, like the last, cannot be submitted to any definite rule, the local conditions of each farmer requiring consideration. I, however, submit the following sample of the five-year course suitable to Puget Sound:

- 1st Year. Fall plowed Clover sod, sown in spring to Flax, pulled in July or August, and sown to Crimson Clover on removal of Flax, 12 to 15 pounds per acre.
- 2nd Year. Fertilize in winter or early spring, and turn under in May, and plant Potatoes, or other root crops; plant Rye or Rape after Potatoes are dug.
- 3rd Year. Plow under Rye or Rape in spring and sow to Oats or Peas, or both, and seed down with Red Clover, Alsike and Orchard and tall Fescue Grass.
- 4th Year. Fertilize Clover sod, and cut two crops of Hay.
- 5th Year. Cut one crop of Hay, and spread manure on aftermath, and turn under deeply, as in first year, and sow to Flax again.

Under this rotation the land is never bare all winter, except one season in the rotation, consequently there is always a crop holding the plant food from being washed away by the winter snow and rain, and the land is improving in fertility each year.

HARVESTING.

Flax, if grown for seed only, may be harvested very cheaply with a self-binding harvester, and the seed threshed out with an ordinary grain thresher having one of the concaves removed. If grown for fibre purposes, the Flax must be *pulled*, and tied neatly in uniform bundles about 6 to 8 inches in diameter; with the butts all evenly set upon one plain, not "higgedly piggedly," sticking out irregularly, up and down the bunch for a foot

or more. Carelessness in this particular will reduce the value of the crop at the mill by from \$1 to \$3 per ton. When the seed has reached the dough stage and is beginning to turn color, is the time to harvest the crop by pulling, which is an expensive process. Mr. Eugene Bosse, a Flax expert in Wisconsin, states that there it took one man thirty hours to pull one acre of Flax; while my experience on Puget Sound required double that time to pull and tie one measured acre of Flax. Some reduction upon that time might be made by experienced pullers—my crew being all unfamiliar with the work. I think \$10 per acre about as low a price as the work can be done for *by hand*. There are in the United States, however, flax-pulling machines that will pull two acres of Flax per day, with two horses, and others of even greater capacity. Consequently where those machines are available Flax may be pulled for \$1.50 to \$2 per acre. When the hand process is adopted, it is necessary to have suitable bands for binding the bundles prepared beforehand. In Ireland rushes are used for this purpose, and great piles of them are gotten ready and distributed over the field by boys. In Europe, Rye or Oat straw is used for the same purpose. The pullers on going to work put a number of those bands around their necks, as many as they can carry, and as sufficient Flax is pulled to make a bundle they draw a band from round their neck and tie the bundle, and boys come along and set them up in stocks or singly to dry. The Americanized system, which I recommend, is to make the bands of binder's twine, about thirty inches long, with a bowline or loop tied at one end of each, as a much larger number of these can be carried round the neck over the shoulders than the more clumsy rushes or straw bands. I also recommend the pullers only to pull and the binders only to bind. Thus both become more expert, and time and cost is economized. The pullers stoop down and lay hold of as much Flax as they can collect by drawing both hands together, and with a jerk pull it free from the ground; then with the right turned backward and the thumb down, make a sweep, inclosing what Flax they can grasp in the right hand and carry it towards the left hand, and jerk it from the ground; as soon as the left hand contains all it can hold sweep it upwards free of still standing Flax; as the bunch comes down let its roots strike the foot or ground with a smart stroke, to knock off the adhering soil, if any there is, and lay the bundle smoothly on the ground; repeat the process, but lay the next bunch across the first, and so proceed until there is enough on the ground in a bunch to make a suitable bundle; then the binder comes along with his bands, and gathering up the Flax jabs the butts on the ground to even them, and secures the bundle with the string tied just below the seed ends, and throws it to one side for the boys to set up in stock. And so the work goes on till all is harvested. It is important to rush this pulling through while the straw is in the proper condition, as the fibre rapidly deteriorates if allowed to become too ripe for best quality of fibre, losing its softness and becoming coarse and harsh. The Flax has now only to dry to be ready for delivery at the mill, as the mill will take the straw with the seed balls on, buying the whole by weight at so much

per ton, at an average price of \$15 per ton, varying, however in price according to quality. The elements regulating its value being length, fineness and uniformity of straw, absence of weeds in the bunches, and care and neatness used in tying them.

Some farmers may, however, wish to save the seed for their own use, in which case the process of rippling is used. This is a slow and tedious process, and where the farmer has not the facilities for the work it will be more profitable for him to sell straw and seed together to the mill, and purchase back what seed he may require. There are several methods of rippling, the most commonly used, however, consists of a comb made of round spikes about one-eighth of an inch apart, over which small handfuls of Flax tightly grasped in both hands are struck and drawn through several times, until all the bolls are stripped off the straw, when the seed and bolls are spread in a layer, one foot or so deep, to dry, being frequently stirred and turned to prevent mustiness. They can then be run through a steam or horse-power thresher to separate the seed from the hulls, and re-cleaned with an ordinary fanning mill supplied with a suitable Flax seed hurdle.

The farmer may now be desirous of having some estimate of the profit to him as a farmer in Flax culture, and although local conditions may modify the figures here given, they will, I think, prove a fair, conservative average.

Growing Flax seed for the oil mills is not a costly operation. Twice plowing, harrowing, rolling and seeding, may be put at \$8 per acre; 3 pecks of ordinary American seed, 90 cents; harvesting with twine binder, threshing and sacking, \$3; say \$12 total cultural expenses. Yield from 15 to 20 bushels of seed at \$1.20—\$18 to \$24; profit \$6 to \$12 per acre. No very big thing, nevertheless fairly profitable if carried out on a large scale.

Growing for seed for sowing for fibre purposes, the cost will be the same for culture and harvesting, \$11, plus a larger quantity of more costly seed, amounting to \$2.50; total, \$13.50. Yield the same as the former, only the product will bring a higher price of \$2 per bushel, amounting to \$30 to \$40 per acre, giving a profit of \$16.50 to \$26.50, or somewhat better.

Growing for seed and fibre, we may figure upon 3 to 4 tons of straw and 15 to 20 bushels of seed per acre. The cultural expenses, however, will be greater, including the hand pulling and the larger amount of seed required, which may be estimated: Cultural expenses as above, \$8; pulling, binding and stocking, \$10; rippling and cleaning seed, \$10; seed, \$3.50; hauling and stacking, or housing, \$3; total, \$34.50. Yield, 3 to 4 tons straw, at \$15—\$45 to \$60; seed, \$18 to \$24; total, \$63 to \$84; profit, \$28.50 to \$49.50 per acre. A result, it seems to me, far more profitable than the farmer can at this time ordinarily obtain.

Carrying this estimate a step further to see what an ordinary farmer can do if he has learned how to ret and hand work Flax by working at odd times in the winter and under cover. Out of this acre of Flax, that cost him \$34.50 to grow, he can produce by hand work between 500 and 600

pounds of fine fibre, worth all the way from 10 cents to 40 cents per pound, without any *cash* outlay, though considerable expenditure of time and labor, but as the greater portion of this labor can be done in the house or barn in winter time, and at spare hours, a material increase of income can be secured with the common facilities to be had upon an ordinary pioneer farm.

This question, however, opens up a large field for investigation, but, having reached the limit of space allowed, must defer its consideration to a future opportunity.

WASHINGTON STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE

EXPERIMENT STATION

PULLMAN, WASHINGTON

BULLETIN 21

SUSCEPTIBILITY OF SPERMOPHILES TO PATHOGENIC BACTERIA

BY

A. B. KIBBE, M. D.

1896

All bulletins of this station sent free to citizens of the state
on application to the Director.

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SUSCEPTIBILITY OF SPERMOPHILES TO PATHOGENIC BACTERIA

BY

A. B. KIBBE, M. D.

In June, 1895, I received from the Agricultural College at Pullman in this State a box containing nine living and four dead and partly eaten spermophili which were sent to me in order to determine their susceptibility to pathogenic bacteria. Several days later I received a second lot from Walla Walla. Of these, originally twelve in number, but four were living; the dead, like those from Pullman, bearing evidence of having been partly eaten. In both boxes there was an abundance of food and the animals had been on the road less than twenty-four hours. In July a third lot was received from Ellensburg of which seven were living and five dead. Of the latter several were partly devoured. Those coming from Pullman, a town in the extreme eastern part of the state, were much larger and heavier than those from the other points which were similar in general appearance. The former I took to be the Franklin spermophile. The others, while resembling the Franklin to some extent, were much smaller. It was impossible to classify them as no description of any known variety seemed to apply. It is probable that they belong to one of the numerous unclassified species.

Before any experiments were undertaken on either variety they were carefully fed and cared for for several weeks in order that their condition at the time of inoculation might be as nearly perfect as possible in a state of captivity.

Literature relative to field pests contains no record, as far as I am aware, of anything bearing on the susceptibility of spermophiles to pathogenic bacteria with the exception of Palmirski's* experiments with the vibrio *Metschnikovi* and recently an article by Mereshkowsky.† The former seems to have merely reported the results of a laboratory experiment and made no attempt to apply his results, striking though they were, to the field, probably owing to the fear of spreading an epidemic among fowls, the organism used having been isolated by Gamaleia from chickens affected with a choleraic disease.

Mereshkowsky's paper deals with experiments made with a bacillus iso-

* Archives des Sciences Biologiques, II, p. 497.

Centralblatt für Bacteriologie, Bd. XVII, No. 21, s. 742.

lated from spermophili dying from an epidemic originating spontaneously. Unfortunately he was unable to determine their susceptibility to cultures of the specific bacillus in artificial media, owing to the severity of the epidemic among the animals sent to the laboratory having been so great that all, some 150, died from infection due to eating the dead. Bacteriological examinations in every instance showed pure cultures of the same bacillus. This species he terms *spermophilus musicus*. Another species, termed *spermophilus guttatus*, was used for experiment owing to his inability to obtain any more of the first variety. They also were susceptible as far as tested by inoculation and apparently to feeding. Whether or not those referred to by both Palmirsky and Mereshkowsky are similar to those inhabiting this country is uncertain.

It was my intention to commence the experiments with Loeffler's bacillus typhi murium but tests with a culture showing it had completely lost its virulence, I was forced to abandon the idea as I found it impossible to obtain a culture sufficiently active. This was particularly disappointing as the pathogenic qualities of this organism have been so thoroughly studied that its dangers are known to be almost nil, that is as far as we know them from laboratory experiment.

Having what I knew to be a reliable culture of the vibrio Metschnikovi, bouillon cultures were prepared and in order to obtain as high a degree of virulence as possible young pigeons were inoculated in the breast muscle. Cultures from the heart blood were then successively used on each of seven full grown pigeons until in the last death took place within seven hours. Two of the Franklin and two of the smaller variety of squirrels each received .5cc of a twenty-four hour old bouillon culture grown in the incubator and a young pigeon as control received a like amount. In the squirrels the culture was injected beneath the skin over the spine, in the pigeons at the usual site of inoculation, the breast muscle. The inoculated squirrels were placed in separate cages and the pigeon, which was found dead the same evening, after opening the breast and preparing cover glass specimens of blood, was placed in a cage containing four Franklin squirrels. The following day the only evidence that a pigeon had ever been in the box was the presence of feathers and well cleaned bones. Forty-eight hours later one of the smaller squirrels was found dead in the cage. Bacteriological examination showed the vibrio Metschnikovi in pure culture though the colonies on the agar plate were comparatively few in number.

The other animals were closely observed for several weeks but presented no evidence of having been in the least affected by the inoculation. Later two more of each variety were inoculated in the same manner with negative results.

From this it would appear that the Russian spermophile, at least the variety used by Palmirsky in his experiments, is a different species.

It has been suggested that the comparative absence of these pests in localities where hogs are raised may be due to their susceptibility to the bacilli of either hog colera or swine plague or to both. Though either of

these organisms would be highly unsuitable for use in the field the question is one of interest and possibly of importance.

To determine whether the observed condition is simply a coincidence or is really based on the fact of their susceptibility to these organisms the following experiments were made :

Two squirrels of each variety were inoculated with .5cc of a bouillon culture of hog cholera the virulence of which was first tested on a rabbit and shown to be active.

Six weeks later, the animals not having shown any evidence of impairment in health, they were inoculated with a like amount of a virulent culture of swine plague without result.

The experiment was next tried of inoculating several of each variety with putrid blood.

For this purpose a small jar of calves' blood was allowed to stand in a warm and dark place in the laboratory for forty-eight hours. Microscopic examination at the end of this time showing bacteria in abundance ; .5cc of the fluid was injected beneath the skin of the back of two squirrels of each variety. One of these only died greatly emaciated at the end of the sixth week. Careful examination, however, failed to show any form of bacterium in the blood or tissues.

The frequency of disease among domestic animals when kept in filthy surroundings and the fact that mice and guinea pigs often develop epidemics in laboratories unless particular pains are taken to keep their cages clean led me to make an attempt to induce, as it were, artificially that which occurs naturally. For this purpose six of the large or Franklin variety and four of the smaller were placed in separate cages and orders given to the laboratory attendant to omit cleaning them. The condition which soon developed was offensive to a high degree as these animals even under the most favorable circumstances emit a decidedly disagreeable odor.

November 6 two Franklin squirrels were found dead and still warm. Both were fat and apparently healthy in every respect. Six hours later a careful bacteriological examination was made. The gross appearances of the abdominal organs, as well as those of heart and lungs, were identical in each. The small intestine, moderately distended with gas, was reddish in color and contained a pale pink fluid, the stomach was but slightly altered, the liver swollen and mottled, kidneys hyperaemic, spleen swollen and dark, lungs congested, small amount of fluid in pericardial sac, heart muscle not materially changed.

Cover-glass preparations from the heart blood showed a number of short bacilli, slightly thinner than typhoid bacilli but of about the same length. Bouillon cultures from heart blood, spleen and kidneys and agar plates from the same gave in every instance pure cultures of the same organism. The colonies on agar grown in the incubator at the end of twenty-four hours were peculiar and resembled those of no other bacillus with which I am familiar. The center of each colony was of a grayish white, somewhat

similar to typhoid but the edges faded away into the surrounding medium so gradually that it was difficult if not impossible to define the boundary. In gelatine plates the colonies, minute in size were surrounded by a fogging of the medium producing a halo-like effect which is characteristic. In sharp contrast to that class of organisms which Hueppe terms the septicaemia haemorrhagica group, this one *liquified* gelatine with great rapidity.

Twenty-four hours later a third squirrel was found dead. Examination showed the same appearance of the liver, kidney, spleen, etc., and cultures gave the same bacillus. The other squirrels were then removed from the cage to a clean and freshly prepared one where one week later a fourth was found dead from the same bacillus.

As it was impossible to obtain any more before the ensuing March or April every precaution was taken to preserve the virulence of the bacillus.

Unfortunately, however, it proved nonpathogenic for rabbits, guinea pigs and white rats, (I had no white mice) nor were the smaller variety susceptible. Before a fresh supply was obtained in March its virulence had vanished to my great disappointment. Every effort to restore it proved fruitless. Its activity in growth on various media seemed not to have become impaired. One feature struck me as being of interest which was the fact that for a month or more bouillon cultures gave off an odor closely resembling that of freshly voided urine from the horse. Later this had entirely disappeared and I have often wondered whether its presence was not due to the co-existence of virulence.

In March, 1896, I obtained from the Bureau of Animal Industry in Washington a culture of the bacillus isolated by Mereshkowsky and at once instituted experiments to determine the susceptibility of the species I had remaining. Two of the Franklin and three of the smaller variety were all that remained of those received in 1895; the others having died from experiment, injury and other causes. One of each variety received .5cc of a twenty-four hour bouillon culture. The Franklin remained unaffected, the other was found dead twenty-four hours later and the bacillus in question found in heart blood, spleen, liver and kidneys. Sections of the latter showed the organisms in colonies very like those observed in the rabbit after death from the hog cholera bacillus.

Early in April a number of the Franklin variety were received from the Agricultural College at Pullman. All were living and in good condition, in marked contrast to those coming from the same place in 1895 later in the season. This would seem to indicate greater vitality soon after hibernating. Four were inoculated subcutaneously and two in the peritoneal cavity but without result. Later in April a dozen of the small variety were sent me from Walla Walla. On placing them in the cage with those of apparently the same species which remained from my last year's stock it struck me that there was a slight difference. Close examination showed a difference in marking. The variety last received were faintly mottled, the hair of their coat being slightly lighter in coloring in small areas, arranged in an approach to parallel lines. This description might possibly

be thought to apply to the *spermophilus tridecemlineatus* but the stripes are not well defined nor the dots regular.

This variety proved to be very slightly susceptible as the following shows.

Four healthy ones received each .5cc of a fresh bouillon culture, two beneath the skin of dorsum and two in the peritoneal cavity. Two weeks later all were still apparently healthy.

One of the small variety from last year's supply was then injected with .5cc and found dead twenty-four hours later. After section, the body was placed in the cage containing the four previously mentioned who immediately proceeded to devour it. Six days later one of them was found dead. Examination showed a condition of the abdominal organs similar to that described by Mereshkowsky as existing in the *spermophili* dead from the same cause. Cultures gave the bacillus in pure state. The remains were then fed to the others, but without result.

Those of the first supply, two in number, were injected with fatal results within twenty-four hours in each instance, but the late spring has prevented my obtaining any more up to the present time so that I am unable to state what the result of feeding cultures of the germ or the bodies of those dead from inoculation would be.

The study of this question has not only been of great interest but has shown itself to have more sides than I anticipated when it was commenced. So little seems to have been known about the habits of these pests by those even who have suffered most from their depredations that all I have learned has been through personal observation and experiment. That there are at least three varieties in this State is certain and I am inclined to think there are more than that number. Relative to the most important factor in the successful carrying out of laboratory experiments, the question as to whether or not these pests in a state of freedom devour their dead, opinions differ greatly. Many maintain strenuously that they do not, while others state that they do so only when the season is very dry. Seattle, where these experiments have been made, is too far from their habitat for me to learn by observation the actual facts, but judging from my experience with the animals I should say they were likely to eat their dead wherever found. If this is true, the whole question simply resolves itself into one of finding an organism which is pathogenic for all three varieties if possible. This would be the ideal, but I very much doubt the likelihood of its occurrence. It is much more probable that a germ will be isolated which will prove pathogenic for one or two species and ultimately such as will prove efficacious in the case of the others. That organisms exist which are suitable I believe to be a well established fact not only from the experience above mentioned relative to the breeding of a laboratory epidemic among the Franklin species but from the testimony of those having lived where the pests were numerous, which is to the effect that epidemics have been known to break out sufficiently severe to practically rid the country of them for several years. Could such an outbreak

be studied by a competent bacteriologist the results would be of unquestioned value.

To wait for the occurrence of an epidemic is too uncertain a method. If the damage done by the pests is sufficient to warrant the expense an attempt should be made in some such manner as above mentioned to artificially produce a disease among them in a specially provided laboratory. The supply of squirrels should be abundant in order to maintain the virulence of the organisms should one be isolated at a time when they are hibernating.

ADDENDUM.

Since the above was written I find that the large variety of squirrel is not the Franklin. Prof. T. S. Palmer of the Bureau of Animal Industry in Washington, D. C., has identified it as the *spermophilus Columbianus*; the variety from Walla Walla he takes to be *spermophilus Townsendi* and that from Ellensburg corresponds to *spermophilus Mollis* or *Kennicotts spermophile*.

WASHINGTON STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE

EXPERIMENT STATION

PULLMAN, WASHINGTON

BULLETIN 22

INFLUENZA

By S. B. Nelson, D. V. M.

OCTOBER, 1896

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on application to the Director.

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INFLUENZA

By **S. V. Nelson, D. V. M.**

Synonyms.—Epizootic Catarrhal Fever; Epizootic Catarrh; Typhoid Fever; Horse Distemper; Pink Eye; Mountain Fever; Shipping Fever; Epizootic, etc.

Definition.—Influenza is a peculiar contagious and infectious, febrile disease, assuming various forms by involving different organs of the body. The organs of respiration and circulation are generally involved, and in some instances the digestive and locomotory organs are implicated.

History.—The very earliest accounts of this disease date back to about the year 1300, when a severe epidemic, recognized as influenza, raged among the horses of Italy. During the seventeenth century, epidemics of influenza are recorded as occurring in Germany and spreading over the surrounding countries of Europe. In the year 1711, it attacked the horses of the armies of Europe, causing great losses. In the eighteenth century, this disease was again observed in Europe and also in America, appearing in London early in 1732, and in America later in that year. In which American city this first outbreak occurred is not on record. During the present century, influenza has occurred epizootically in European and North American countries, at intervals from the year 1850 up to the present date. In America, an extensive and very virulent outbreak occurred in 1872-73. This outbreak commenced in Toronto, Canada, in the latter part of September, 1872. Radiating from Toronto, it spread rapidly to every city and town in Canada. It spread south into the United States going as far south as Virginia; at the same time traveling westward, so rapidly, that in a few months it reached the states and territories of the far west, from which it passed north into British Columbia, and south into Mexico and South America,

Today it might be designated a permanent disease among the horses of certain sections of this country, and especially in large cities, where the disease is kept alive by the introduction of green horses into the large exchange stables. These new horses generally suffer from an attack a short time after being placed in the stables, although none of the other horses there have the disease at that time.

Causes.—The causes of influenza are direct, and indirect or predisposing. The direct cause is a micro-organism which has not been isolated until lately, and about which, as yet, not very much is known.

Indirect or Predisposing Causes.—Influenza, like other contagious diseases, is influenced in its spread by predisposing or favoring influences.

There is no doubt, that the severity of an attack of influenza, depends greatly upon the conditions in which the disease finds its patient. The causes which render an animal more susceptible to the action of the virus are, neglect of every kind; overwork; change of location, for instance, from the country to the city or sometimes from the city to the country. Age is also a predisposing cause, as young horses are more severely affected by the disease than older horses; the latter when they are affected, have influenza in a much milder form. Whether or not colts have this disease is yet to be determined.

Influenza may occur any season of the year, but it is more prevalent during spring and autumn, than the seasons of summer and winter; because during those periods horses shed their coats of hair and consequently are very susceptible to atmospheric changes, which should they be exposed to, would very likely cause common colds and coughs. When the animal is in such condition he becomes an easy victim to the disease, if it is prevailing in the neighborhood. Poor sanitary conditions, in and about the stable, are also a predisposing cause; for instance, dark, damp, filthy stables, draughts of cold air through the stables, or defective ventilation; these all tend to lower the vitality or natural strength of the animal.

Symptoms.—The symptoms of influenza manifest themselves four to ten days after exposure. They vary in accordance with the different organs affected. For the sake of convenience of

description, we will classify influenza, as Catarrhal and Pharyngeal, Pulmonary, Abdominal, and Rheumatic.

Catarrhal and Pharyngeal Form.—The first symptoms are rigors or shivering fits, which last from three to five hours, these may occur unobserved; they are followed by a dry, staring coat, the hair standing on end; partial or entire loss of appetite; the animal sneezes frequently and has a short dry cough. Now if the animal is given a close examination, the surface temperature is found unevenly distributed, for instance; two legs may be cold and two warm, or one leg cold and three legs warm, or vice versa.

There is some swelling about the throat which is tender and painful to the touch. The membrane lining the nose is red and dry. The temperature has risen to 104° or 105° F. The pulse is increased in number varying from fifty to sixty per minute, and may even be higher. At first it is moderate in force but soon becomes weak.

After the dry stage of the mucous membranes, they commence to discharge a thin, watery fluid which is sometimes mixed with flaky mucus; as the disease advances this discharge becomes thicker and more copious. The soreness of the throat increases with the advancement of the disease, as is shown by the paroxysms of coughing caused by handling the throat, or by the animal's efforts to swallow food or water, which at times is returned through the nose. It is often the case that the patient is unable to swallow liquids, while it still retains the power of swallowing solid food. The secretions of the body are much altered; the bowels are torpid, the droppings being dry and pellety, as well as coated with mucus; while the urine is scanty and highly colored. In a week to ten days, if the disease terminates favorably, all the symptoms become lessened in severity; the temperature declines, the pulse becomes stronger, the appetite increases, and the cough becomes softer and less in frequency; return to health resulting about two weeks after the commencement of the attack.

It frequently occurs, when the termination of this form of the disease is not entirely favorable, that roaring or whistling results, if the pharyngeal region has been severely affected; or chronic catarrh may remain if the mucous membranes of the head have been the seat of intense lesions. This latter is very common in

this section of the country, where horses are allowed to range.

Pulmonary or Thoracic Form.—The symptoms manifested in this form of influenza, vary but slightly from the ordinary symptoms of pneumonia ; the rapid breathing, the heaving sides, dilated nostrils, pinched expression of the face, stupidity from imperfect aeration of the blood, are all observed. The patient places himself in the most favorable position to obtain as much pure air, as possible. The color of the nasal membranes is much darker than in the preceeding form. The thoracic form is frequently seen in older horses, and is quite serious in its results ; it being at times followed by inflammatory conditions of the heart. In such instances the disease generally proves fatal.

Abdominal or Enteric Form.—The first observable change of symptoms, from the ordinary form of the disease, is a distinct abdominal pain, manifested by the animal's being very restless, he kicks at his belly with his hind feet, paws the ground, lies down and rises again, but even while he is down he is not at ease and continually turns his head, in an anxious manner towards the flank. The membranes of the eyes, nose and mouth become violet in color, and later on, when the liver is seriously affected, assume a yellow tinge. The tongue is dry and furred, the excrement from the bowels is scanty, dry and hard, it is in small pellets covered with mucus but not often with false membranes. The appetite is absent but thirst is present. The abdomen is tender to the touch, especially over the region of the liver. The pulse has increased in number and is small and wiry. It is the very same pulse which is observed in inflammation of the bowels. The respirations are increased in proportion to the pulse and are nearly thoracic. Towards the latter stage of this form a very serious diarrhoea occurs, and when this cannot be controlled or stopped, great prostration results, and the patient succumbs to the disease.

If however the diarrhoea is stopped, the alarming symptoms disappear and the patient will generally make a slow recovery, remaining poor and thin in flesh, for some time.

Rheumatic Form.—Rheumatism rarely occurs at the same time or during the period that the disease is increasing in severity, but rather consequently to its having reached its climax and the animal has commenced to improve, or it may occur as a sequel

just at the time when the animal is nearly convalescent ; still the tendency towards rheumatism may reveal itself in the earlier stages of the disease, by stiffness of the limbs and crackling of the joints.

When the patient becomes affected with rheumatism, the previous symptoms of simple catarrhal fever become aggravated.

Rheumatism may manifest itself as affecting certain muscles, but it is most frequently observed in or about the joints, affecting the tendinous tissues of these regions. Frequently a patient appears to be doing very nicely under treatment, when in a few hours or perhaps over night, a change occurs, the tendinous structures of the body becoming affected and the animal is crippled. The structures most frequently affected under such circumstances are the flexor tendons of the leg, commonly known as the cords. They are hot and swollen, also very tender when handled or felt of. This condition may shift or change from one leg to the other in a very short time.

I have observed, that in this state finely bred animals are more often affected with this complication than the animals of the coarser breeds, also that the symptoms of rheumatism continue a variable length of time after the apparent return of health from the attack of influenza. Other complications, in addition to those just described, are occasionally met with, but not often. They are paralysis from the disease affecting the spinal cord ; dropsy and dropsical swellings, the latter affecting the lower extremity of the limbs, and the under surface of the chest and abdomen.

This is seen in young horses rather than in older ones.

Sometimes when the disease localizes itself in the eyes, the patient upon recovery is left entirely blind.

Results of Influenza.—The greater percentage of cases of influenza recover without any permanent structural changes in the organs of the body, but all are not thus fortunate. Occasionally certain organs remain in an abnormal condition, such as the heart, lungs, kidneys ; or there remain enlargements of the tendons of the large muscles of the limbs, chronic swelling of this or that joint, blindness, catarrh, gleet, roaring or whistling.

TREATMENT.

The treatment must consist of both hygienic and medicinal measures.

The patient must be laid off from work, if working when taken sick. After this, if it is possible, place him in a dry, light, clean and well ventilated boxstall. If no boxstall is available, place him in a single stall in which there is plenty of good fresh air but no draught. It is much easier by keeping the animal covered with blankets, to regulate the surface temperature. The blankets should be daily removed from the patient, and replaced after being cleaned.

Give the patient light, sloppy foods, and as much as he will eat of them.

If the appetite fails, as it often does, green grass when it can be procured is to be preferred to hay.

When the bowels become constipated do not physic the patient severely, but rather try to overcome the constipation with enemata of clear warm water; also give in feed morning and evening, two ounces of either epsom salts or raw linseed oil. Do not give an animal lukewarm water to drink, as there are very few horses that like it or will even drink it without being taught to do so; rather give them cold water, not too much at a time but often; or linseed tea or milk, these latter two are nourishing and will relieve irritation of the mucous membranes.

To relieve the dryness and irritability of the nasal mucous membranes, prepare a pailful of boiling water, cut the bottom out of a sack and draw the sack over the pail of water and the patient's head so that the steam from the boiling water will rise up through the sack causing the patient to breathe it.

Into the boiling water should be stirred an ounce of turpentine, chloroform or ether, or a teaspoonful of carbolic acid. Stir the water with a wisp of hay or straw. The patient should be steamed three times daily, about fifteen minutes at each time. Afterwards rub the patient's head dry so that he will not catch cold. Now, in giving medicinal agents, I have found, that very good results are obtained by giving to the patient in his drinking water, three times daily, two to four drachms of potassium nitrate or potassium chlorate. If the fever is high, give acetanilid three

drachms, quinine thirty grains ; morning, noon and night until the fever is reduced. When the patient's throat is very sore, much benefit is derived from the following :

Camphor, pulv.....	Four ounces.
Solid Ex. of Belladonna.....	Two ounces.
Liquorice Root, pulv.....	Eight ounces.
Simple Syrup, enough to make into a sticky mass.	

Give one teaspoonful four to five times daily. With a long handled spoon place it between the animals back teeth, where it will gradually be softened and swallowed.

In cases where the cough remains, after the patient has apparently recovered, the throat should be bathed with cantharides liniment, night and morning, for a period of four or five days unless vesicles appear sooner. Should this not relieve the trouble, a blister must be applied to the throat. A very good blister is made, as follows :

Mercuric Iodide... .	One drachm.
Cantharides, pulv	One drachm.
Cosmoline	One ounce.

This must be well rubbed together and thoroughly mixed.

To apply the blister the hair must be closely clipped from the part to be blistered. The part must also be washed and rubbed dry. Now rub on a small part of the blister, constantly rubbing on a little more. The blister must be well rubbed in for a minute or two ; and at last a layer one-eighth of an inch thick applied. Tie the patient in such a manner that he cannot bite or rub the blistered surface.

The following day he may be given his head, but must not be exercised for a week or two. Nothing is to be done to the blistered surface, unless it becomes hard and dry, when a little sweet oil should be applied to soften the scabs.

In patients that present abdominal complications, hot woollen cloths should be applied to the abdomen. The patient should also be given injections of tepid water every hour.

Where the pain is more persistent one or two grains of morphine, in a small quantity of water may be given to the patient to allay the pain.

The sequel or complication, rheumatism, must be combated by hot applications either wet or dry, as hot bandages, poultices or

small sacks of hot salt bound about the joint. Whenever a joint is affected with rheumatism and there is intense pain a bandage of soft material should be applied about the swollen joint to protect it and prevent it from being bruised or struck in any manner.

In giving internal treatment for this trouble I have had very good results from using sodium salicylate in three drachm doses, given in the feed morning, noon, and night.

After apparent recovery there may be swellings or thickening of joints or tendons. If so they should be blistered. The application of blisters has been described earlier in this bulletin. It is sometimes necessary to apply a blister the second time, when such is the case it should be done ten to fourteen days after the effect of the first blister has subsided.

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**SOME NOTES CONCERNING THE NITROGEN
CONTENT OF SOILS AND HUMUS**

By Elton Fulmer

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SOME NOTES CONCERNING THE NITROGEN CONTENT OF SOILS AND HUMUS.

BY ELTON FULMER.

Four or five years ago the author of this article became convinced that the humus was not receiving the attention from agricultural chemists that its importance as a factor of soil fertility demanded. Only a small proportion of the soil analyses that have been reported by the various experiment stations have included even a determination of humus percentage; and a much smaller proportion have included a determination of the percentage of organic nitrogen, or that contained in the "*matiere noire*." Only rarely do we find an analysis that includes the estimation of the nitrogen in the soil in the form of nitrates, nitrites, etc. That this disregard of the humus has been largely due to a natural reaction from the other false extreme of considering it of paramount importance, there can be no doubt. A few agricultural chemists in the United States, notably Hilgard, Jaffa and Snyder, have in the past few years given some detailed attention to the subject. The results of their work together with those of some European investigators, particularly Bréal, Dehérain, Joffre, Berthelot and André, have given an added interest to investigation along this line.

Berthelot and André have shown * that humus in soil as well as artificial humic acid has the power of absorbing a considerable quantity of potash from dilute (1%) solutions containing it. They also found from the ultimate organic analysis of four soils rich in humus and four poor in humus, that in the former, containing from 32.9 to 72.3 per cent. organic matter, the nitrogen varied from 1 to 1.7 per cent.; while in the latter, with from 1.41 to 3.25 per cent. organic matter, the nitrogen ranged from .09 to .14 per cent. They further showed that 67.1 per cent. of the

* Compt. rend., 116 (1893).

total organic carbon was soluble in dilute solutions of alkalis, 27.1 per cent. of which could be reprecipitated by acids. The carbon insoluble in alkali contained 4 per cent. nitrogen, the soluble extract precipitable by acids, 5.6 per cent., and that not precipitated by acids 9.7.

Bréal has shown *by experiments that recently germinated plants of lentils, wheat and beans grown in a weak solution of humate of lime developed more rapidly than when grown in a solution of potassium nitrate, potassium phosphate, or ordinary water. He obtained further confirmatory evidence that plants may assimilate humus directly, by placing in a highly colored solution of humate of potash, a tuft of *Poa Annua* divided into two portions, one of which had the upper part of the plant removed. This tuft had been specially prepared for the experiment by cutting off the roots which had developed in the soil, and placing it in water until new white roots had formed. In two days the humate solution in which the roots with attached tops had been placed, had become almost colorless, while the other was apparently unaltered. These and other experiments carried out by the same investigator seem to demonstrate the ability of plant roots to directly assimilate organic carbonaceous substances.

Böhm had previously shown that bean plants could regain their starch destroyed by being kept in darkness, when their stems and leaves were placed in a solution of sugar.

Joffre concludes † from pot experiments with buckwheat and white mustard that Bréal's assertions concerning the assimilation of humus by plants, are well founded.

The conclusions drawn from experiments at the Grignon station by Dehérain are that *Gramineae* can obtain all the necessary nitrogen from sodium nitrate—but that legumes, especially clover, require humic food. The experiments of Dehérain with chemical and organic manures forced the conclusion that humus has a more important function than a mere reservoir of nitrogen. His results showed further that a decline in fertility resulted from a decrease of the humus content. This has recently been confirmed by Snyder.‡

* Ann. Agron., 20 (1894).

† Bul. Soc. Chim. Paris, 13-14 (1895).

‡ Minn. Sta. Bull. 30.

Hilgard and Jaffa have shown* that there is a somewhat definite relation between the percentages of humus and organic nitrogen, the latter ranging from 6 per cent. of the humus as an extreme in soils of the humid regions, to 19 per cent. as an extreme in the arid soils. The importance of the humus in the economy of plant production as shown by the experiments above mentioned furnished an added zest to the work detailed in the following pages.

The investigations of Berthelot and Andre' in particular concerning the solubility of the organic carbon in alkalis, and the nitrogen content of the soluble and insoluble portions, are especially suggestive of great interest in further study.

The work which is detailed in this article simply consisted of two determinations of nitrogen in the same soil—one of the total nitrogen in the soil (including of course, nitrates and ammonium salts, as well as organic nitrogen—and one of the percentage of nitrogen in the humus. The work was first planned for only a few samples of soil, in the hope that the relation between the total nitrogen, and that contained in the humus might furnish a clue as to the cause of infertility, where the physical condition of the soil was satisfactory, and chemical analysis revealed an abundance of potash, phosphoric acid, lime, and total nitrogen by the Kjehldahl method. The relation between fertility and the percentage of organic nitrogen seemed so marked in these few cases that it was determined to carry the investigations further.

In the following discussion, the terms "organic nitrogen" and "available nitrogen" are used interchangeably, meaning in either case the *nitrogen in the humus*. It should be noted that this meaning is somewhat different from that usually attached to these phrases. In discussions of soil nitrogen, the term "available" is ordinarily used with reference to the nitrogen existing as nitrates, nitrites and ammonium compounds. We prefer to use this term with reference to the humic nitrogen because it is greater in amount and more constant, the water soluble nitrogenous compounds (or nitric nitrogen) being present in soils in minute quantities, and being subject to large variations at different seasons of the year.

Strictly speaking, the term "organic nitrogen" should mean

* Cal. Sta. Report—1892-93.

all of the nitrogen in the soil except that existing as nitrates, nitrites, etc. We use it in connection with the humic nitrogen, because so far as our present knowledge goes, this portion constitutes the reserve plant food, although as Berthelot and Andre' have shown *the unhumified organic matter in the soils examined by them contained 4 per cent. of nitrogen.

Hilgard's conclusion that any soil in which the humus contains less than 2.5 per cent. of nitrogen is to be suspected of "nitrogen-hungriness," seems to be fully verified by my results. As will be seen from the following soil descriptions, all the samples whose humus contains less than 2.5 per cent. nitrogen are not productive soils—thus suggesting a lack of nitrogen, although it is particularly noticeable that these same soils are gravely deficient in potash. The only exception to this is No. 73, which is a very productive soil although containing only 1.49 per cent. of nitrogen in the humus.

The very great difference found by Hilgard and Jaffa between the percentages of humic nitrogen in arid soils, and in soils of humid regions, is not fully confirmed by this work, although the samples of arid soils tested were too few to warrant any conclusion.

In comparing the results obtained from the different samples a very interesting coincidence (perhaps a more important relation) may be seen. Nineteen of the fifty-three samples analyzed, yield results showing a relation which may be expressed by the formula $C = \frac{b \times 55}{a}$, where a = percentage of humus; b = percentage of total nitrogen in soil; C = percentage of nitrogen in the humus. The above formula is discussed toward the close of this article.

In all of this work, the humus was determined according to the method of Grandeau, by extraction with 6 per cent. ammonia after liberation from lime and other bases by dilute hydrochloric acid.

The total nitrogen was determined in the original soil by the Kjehldahl method modified to be applicable in the presence of nitrates.

Organic nitrogen was determined in the extract obtained by treating the soil with a 5% solution of caustic soda. All, or an aliquot part of this extract was acidified with sulphuric acid,

* Compt. rend , 116 (1893).

evaporated, and submitted to the Kjehldahl method. Decinormal solutions of ammonia and hydrochloric acid were used. Cochineal was employed as an indicator.

In some cases, the percentage of phosphoric acid associated with the humus was also determined. The results are tabulated by counties, and, in order to give an idea of the general character of the soil, the percentages of organic matter, phosphoric acid, lime, potash and ferric oxide are given in connection with each. We do not attempt to draw any conclusions from the results obtained, but simply state them as they are.

SPOKANE COUNTY.

	30	114	115 Subsoil	119	120
Humus.....	2.760	1.469	.182	3.300	3.170
Total Nitrogen in soil.....	.154	.131	.012	.335	.414
Organic Nitrogen in soil.....	.138	.071	.004	.256	.214
Nitrogen in humus.....	5.000	4.830	2.160	7.760	6.760
Phosphoric Acid in humus.....			.009	.043	.029
Organic matter.....	10.507	7.060	2.160	10.373	11.307
Phosphoric Acid (P_2O_5).....	.265	.096	.153	.070	.096
Lime..... (CaO).....	.604	.644	.431	.874	.908
Potash..... (K_2O).....	.436	.374	.550	.663	.651
Iron Peroxid....(Fe_2O_3).....	4.461	2.984	4.400	3.617	3.617

No. 30 is a very rich soil consisting largely of wash from Mica peak (granitic.) It is now used for growing celery. Its adaptability to this crop is doubtless due to an abundant supply of total nitrogen, 90 per cent. of which is found in the humus, constituting 5 per cent. of its weight. Nos. 119 and 120 are samples of the "Spokane gravel," and fairly represent about one-fourth of the area of Spokane Valley, containing about sixty square miles.

No. 119 has been in cultivation several years and No. 120 is the same soil uncultivated. It will be noted that the old soil has less total but more available nitrogen than the new, and hence a greater percentage of nitrogen in the humus. The old soil also has less organic matter and more humus than the new. In the old soil the organic nitrogen is 76 per cent. of the total, while in the new it is only 51.7 per cent. Inasmuch as the old soil has never been fertilized with humus forming materials these facts would seem to indicate that cultivation has a tendency to make available the nitrogen contained in the unhumified organic matter, or, in other words, to promote the humifying process. No. 115 is the sub-soil of No. 114 which is also a sample of the "Spokane

gravel," although containing a smaller proportion of organic matter and humus than Nos. 119 and 120. In this sample 54.2 per cent. of the total nitrogen is contained in the humus. These large percentages of available nitrogen explain in a measure at least, the great productivity of the Spokane gravel which contains only from 15 to 30 per cent. of fine earth finer than one-half millimeter. The percentages of humus are unusually high for semi-arid soils.

JEFFERSON COUNTY.

	42	43	175
Humus.....	1.648	.420	5.010
Total Nitrogen in soil.....	.173	.102	.193
Organic Nitrogen in soil.....	.020	.018	.169
Nitrogen in humus.....	1.195	4.220	3.366
Phosphoric Acid in humus.....	.001		.014
Organic matter.....	8.607	3.793	14.973
Phosphoric Acid (P_2O_5).....	.109	.085	.089
Lime..... (CaO).....	.154	.579	.219
Potash..... (K_2O).....	.019	.022	.054
Iron Peroxid... (Fe_2O_3).....	5.124	5.215	5.395

Nos. 42 and 43 were sent by Edward Cameron of Bogachiel. Concerning No. 42 he says: "It is upland soil covered with timber, chiefly hemlock. It will not produce unless burnt over." No. 175 was sent by M. W. Felmly also of Bogachiel, who writes as follows: "It is hill land covered with hemlock. It will not produce or even sprout anything when turned up eight inches deep. Where it is burned over it produces good hay, providing it is not turned up."

According to these descriptions, Nos. 42 and 175 are of the same type as far as crop production is concerned, but are very different in composition. Both samples contain too little potash and lime to be productive, and No. 42 would seem to be deficient in nitrogen, its humus containing only a trifle more than 1 per cent. (11.5 per cent. of the total), while No. 175 has three times as much humus, and eight times as much available nitrogen. One might however expect abnormal soil conditions in this region because of the excessive rainfall which amounts to about 100 inches per annum,

SAN JUAN COUNTY.

	44	45	46
Humus.....	29.810	3.570	1.062
Total Nitrogen in soil.....	2.189	.244	.071
Organic Nitrogen in soil.....	.111	.097	.021
Nitrogen in humus.....	3.734	2.732	3.980
Phosphoric Acid in humus.....	.029	.075	.105
Organic matter.....	74.367	11.300	4.513
Phosphoric Acid (P_2O_5).....	.105	.365	.273
Lime..... (CaO).....	1.468	.538	.448
Potash..... (K_2O).....	.000	.000	.000
Iron Peroxid....(Fe_2O_3).....	.482	4.823	3.617

Nos. 44, 45 and 46 are from Lopez Island. The most remarkable thing about these samples is the absence of weighable amounts of potash. Such surprising analytical results with reference to this element, were not accepted until re-determinations had shown their accuracy. While the potash percentages are as a rule low in Western Washington, we are entirely unable to account for this unparalleled case. It goes without saying that these soils are not highly productive. Nos. 45 and 46 are described as the same soil, the former having been in cultivation two years, the latter being new. Forty per cent of the total nitrogen in No. 45 is contained in the humus, and only 29.5 per cent of the total in No. 46 is humic nitrogen. As in case of Nos. 119 and 120, this also seems to indicate that cultivation tends to make available the nitrogen contained in the unhumified matter. If these samples from Lopez Island are accurately described we have the anomaly of a cultivated soil containing $3\frac{1}{2}$ times as much humus as the same soil in virgin state.

OKANOGAN COUNTY.

	71	74	76	77
Humus.....	.520	1.490	2.900	1.222
Total Nitrogen in soil.....	.079	.051	.256	.102
Organic Nitrogen in soil.....	.018	.037	.055	.063
Nitrogen in humus.....	3.410	2.500	1.900	5.160
Phosphoric Acid in humus.....	.005			
Organic matter.....	5.250	8.900	6.3 0	3.527
Phosphoric Acid (P_2O_5).....	.112	.288	.096	.112
Lime..... (CaO).....	2.084	4.679	.714	.614
Potash..... (K_2O).....	.341	.347	.006	.019
Iron Peroxid....(Fe_2O_3).....	1.598	1.808	3.466	1.748

Nos. 71 and 74 are from Lakeside and are described by C. W. Feickert as follows; "No. 1 (Lab'y No. 71) had a dense growth of rye-grass, and No. 2 (Lab'y No. 74) was taken a few hundred

feet from No. 1. I have very poor success on either. All plants on No. 1 are very sickly and yellow. It has grown fairly good grain, and has been in cultivation five years. This spring I planted an orchard on it and almost all of sixty trees will die. It is sub-irrigated and has good natural drainage. On No. 2 I planted strawberries, and those that survive are as yellow as gold."

This description which indicates a lack of nitrogen available for plant use, is in harmony with the percentages of total and humic nitrogen which are much lower than usually found in this state. These soils are undoubtedly suffering from nitrogen hungriness in spite of the fact that they are highly calcareous, and the humic nitrogen is up to Hilgard's standard of 2.5 per cent. It is noticeable that their iron percentages are very low. This may have some significance. Nos. 76 and 77 are also from near Lake Chelan. No statement was made concerning their fertility. No. 76 is doubtless lacking in available nitrogen as well as in potash. The organic nitrogen is only 20 per cent. of the total—and as the amount of nitrates, etc. is very small, a large proportion of the total soil nitrogen is locked up in the unhumified portions of the organic matter. No. 77 has 63 per cent. of its total nitrogen in the humus.

WHITMAN COUNTY.

	5	72	73
Humus .....	.850	2.486	1.190
Total Nitrogen in soil.....	.110	.173	.151
Organic Nitrogen in soil.....	.024	.059	.018
Nitrogen in humus.....	2.780	2.390	1.490
Phosphoric Acid in humus.....		.063	.036
Organic matter.....	3.612	8.733	5.960
Phosphoric Acid (P_2O_5).....	.142	.361	.121
Lime..... (CaO).....	1.081	.456	.514
Potash..... (K_2O).....	.635	.471	.332
Iron Peroxid..... (Fe_2O_3).....	4.554	3.828	4.220

No. 5 is from the College farm at Pullman. It is a very productive soil, showing in field tests no lack of nitrogen, although the percentage of organic nitrogen (.024) is lower than in some soils less productive. Nos. 72 and 73 are also productive soils in spite of their low percentages of nitrogen in the humus. These samples are from Garfield. The organic nitrogen in these three soils represent from 8.5 per cent. to 33 per cent. of the total—a very low percentage.

WHATCOM COUNTY.

	75	78	79	139	140	141	142
Humus.....	3.292	23.450	2.828	1.450	2.314	.386	2.050
Total Nitrogen in soil.....	.250	1.064	.182	.154	.184	.020	.204
Organic Nitrogen in soil.....	.072	.904	.058	.071	.067	.015	.134
Nitrogen in humus.....	2.180	4.013	2.055	4.890	3.980	2.890	6.530
Phosphoric Acid in humus.....	.077	.208	.054	.086	.063	.017	.085
Organic matter.....	10.733	46.367	9.067	6.293	7.860	2.957	7.480
Phosphoric Acid (P_2O_5).....	.294	.285	.067	.139	.084	.144	.265
Lime..... (CaO).....	.324	.409	.359	1.234	1.044	1.326	.891
Potash..... (K_2O).....	.006	.142	.021	.316	.483	.275	.319
Iron Peroxid....(Fe_2O_3).....	5.365	.814	3.919	6.029	4.601	4.823	16.398

Nos. 75, 78 and 79 are from Mountain View. No. 78 was taken from a peat marsh which had been burnt off to a depth of four inches. Nearly 90 per cent. of the total nitrogen is found in the humus. Concerning Nos. 75 and 79 it was written: "Peas and clover make splendid crops on this soil without manure or other fertilizers. Carrots, potatoes and rutabagas grow fair crops—wheat, oats, and timothy almost a failure."

While Nos. 72 and 73 are exceptions to the statement of Hilgard that soils are nitrogen hungry where their humus contains less than 2.5 per cent. of nitrogen, Nos. 75 and 79 are confirmatory of it. The fact that nitrogen fixing plants like the legumes thrive upon a soil that refuses to produce cereals, is indicative of a lack of available nitrogen stored in the soil. This fact of experience is confirmed by the analysis which shows only a little more than 2 per cent. of nitrogen in the humus—this organic nitrogen being 28.8 per cent. of the total in No. 75, and 32 per cent. in No. 79.

Nos. 139, 140, 141 and 142 are from Sumas City. While they are all somewhat deficient in potash, as shown not only by analysis but also by the crops grown, the character of the crops do not give any indication of a lack of nitrogen. This fact of experience could be predicted from the analytical results which show not only a large percentage of nitrogen in the humus, but also, with the exception of No. 141, a large amount of total nitrogen. In the case of No. 141 however, 75 per cent. of the total nitrogen is organic. The high percentage of humic nitrogen in No. 142 might perhaps be expected from the fact that it is from a creek bottom.

KITSAP COUNTY.

	80	81	124	126
Humus.....	32.150	.432	.780	1.120
Total Nitrogen in soil.....	1.221	.059	.098	.092
Organic Nitrogen in soil.....	.046	.012	.034	.089
Nitrogen in humus.....	1.420	2.736	4.390	8.003
Phosphoric Acid in humus.....	.009	.003	.014	.028
Organic matter.....	74.700	3.080	5.580	5.960
Phosphoric Acid (P_2O_5).....	.048	.019	.026	.045
Lime.....(CaO).....	1.970	.308	.659	.534
Potash.....(K_2O).....	.085	.010	.111	.054
Iron Peroxid.....(Fe_2O_3).....	.241	2.126	2.622	3.105

Nos. 80 and 81 were sent from Port Orchard, and Nos. 124 and 126 from Sidney. No. 80 is a peat soil having only a small proportion of organic nitrogen. Practical experiments in Kitsap county have shown that the soils are generally more benefitted by potash and phosphoric acid fertilizers than by those containing nitrogen. The reason for this result of field tests is shown by the analysis of Nos. 81, 124 and 126—the potash and phosphoric acid being deficient while the percentage of nitrogen in the humus is satisfactory although the total nitrogen is not present in large amounts. The humic nitrogen in No. 126 is abnormally high for the Puget Sound region.

SKAGIT COUNTY.

	82	83	84	85	86	100	101
Humus.....	.600	.180	.250	.328	.596	2.990	2.740
Total Nitrogen in soil.....	.142	.102	.051	.079	.185	.307	.366
Organic Nitrogen in soil.....	.041	.022	.022	.028	.041	.167	.287
Nitrogen in humus.....	6.895	12.040	8.668	8.410	6.940	5.600	10.460
Phosphoric Acid in humus.....	.015	trace	.006	.013	.015	.068	.018
Organic matter.....	4.367	1.500	1.867	2.250	4.760	9.233	8.600
Phosphoric Acid (P_2O_5).....	.089	.070	.045	.144	.267	.304	.205
Lime.....(CaO).....	1.049	.832	.891	.891	1.081	.474	.518
Potash.....(K_2O).....	.111	.057	.006	.014	.129	.186	.028
Iron Peroxid.....(Fe_2O_3).....	3.979	1.507	1.718	2.140	3.165	6.039	5.546

Nos. 82, 83, 84, 85 and 86 are tide lands sent from Anacortes. They are not to be considered as normal soils, but we insert them as a matter of interest.

Nos. 100 and 101 are from La Conner. These two samples are interesting. They were both taken from the same field which had grown oats for seventeen consecutive years without the use of fertilizers. The oat straw has been burned each year. No. 100 was taken from a spot of about an acre upon which cabbages turn yellow, and will not head. The remainder of the field pro-

duces excellent cabbages. The land was reclaimed by dykes from both salt water and fresh river water overflows—and the entire field presents the same physical conditions. We were requested to ascertain if possible the cause of the peculiarity of No. 100 toward cabbages. Both samples grow oats and grass equally well. The chemical analysis shows that so far as potash, phosphoric acid, and lime are concerned, No. 100 is the stronger soil, having one-half more phosphoric acid and seven times as much potash as No. 101, although in both cases the percentage of potash is very low. It will be seen however that in No. 100 the humic nitrogen is only a little more than one-half as much as in No. 101, and to this fact we must ascribe (in the absence of any other apparent cause) its failure to produce cabbages, although from theory one would not expect it to be lacking in available nitrogen. Of the total nitrogen in No. 100, 54.4 per cent. is in the humus, while No. 101 has 78.4 per cent. of the total in the humus.

YAKIMA COUNTY.

	91	92	93	94	137
Humus .....	.084	.128	.148	.182	.150
Total Nitrogen in soil .....	.059	.051	.082	.055	.032
Organic Nitrogen in soil .....	.004	.004	.004	.008	.010
Nitrogen in humus	4.700	3.080	2 660	4.330	6.570
Phosphoric Acid in humus .....	.010	.004	.010	.003	.008
Organic matter	3.533	2.718	1.733	2.513	1.560
Phosphoric Acid (P_2O_5) .....	.128	.174	.141	.153	.029
Lime.....(CaO)	2.389	.909	1.259	1.469	1.154
Potash.....(K_2O) .....	.189	.149	.310	.047	.455
Iron Peroxid.....(Fe_2O_3)	6.299	7.053	3.316	6.330	4.521

Nos. 91, 92, 93 and 94 are supposed to fairly represent the different kinds of soil found in the Sunnyside district. This is an arid region, and the most notable characteristic of the soils is the low percentage of humus; and hence, although the organic nitrogen is only a very small portion of the total, yet it constitutes from 2.6 to 4.7 per cent. of the humus. According to Hilgard these would be very low percentages for such a dry region. The samples are from uncultivated soils, now covered with sagebrush. No. 137 is also a sample of virgin soil taken from the Kennewick valley. The amount of total nitrogen is too low in all of these samples. Field experiments in the Kennewick valley have shown that the soil is deficient in available nitrogen.

KING COUNTY.

	102	129	179
Humus.....	2.640	.690	18.100
Total Nitrogen in soil.....	.269	.067	.512
Organic Nitrogen in soil.....	.160	.050	.403
Nitrogen in humus.....	6.050	7.190	2.228
Phosphoric Acid in humus.....			
Organic matter.....	7.990	4.213	25.087
Phosphoric Acid (P_2O_5).....	.057	.070	.390
Lime.....(CaO).....	.389	.599	.404
Potash.....(K_2O).....	.004	.057	.142
Iron Peroxid.....(Fe_2O_3).....	3.105	3.105	1.398

No. 102 is a sample from soil that has been cultivated ten years or more. Its fertility is declining, due, as the analysis shows, to a lack of potash and phosphoric acid. The nitrogen percentage is satisfactory. No. 129 is virgin soil. The same soil when cropped requires stable manure to make it productive. Its total nitrogen is low, but about 75 per cent. of it is found in the humus. No. 179 is from a stratum of reddish material, nine inches thick, lying six inches under a black soil near Green Lake. It is very hard. The analysis shows it to be very rich in humus and nitrogen, 80 per cent. of the latter being organic.

	Thurston Co.		Snohomish Co.	
	184	176	103	177
Humus.....	3.822	5.793	3.006	2.150
Total Nitrogen in soil.....	.189	.407	.158	.138
Organic Nitrogen in soil.....	.119	.311	.039	.020
Nitrogen in humus.....	3.120	5.373	1.311	.918
Phosphoric Acid in humus.....			.047	
Organic matter.....		11.193	8.627	6.307
Phosphoric Acid (P_2O_5).....		.320	.176	.237
Lime.....(CaO).....		.506	.414	.704
Potash.....(K_2O).....		.076	.051	.218
Iron Peroxid.....(Fe_2O_3).....		3.778	4.039	4.730

THURSTON COUNTY.

No. 184 came from near Olympia. It is a type of soil in which many orchards are growing—especially prune orchards. A large number of the trees five years old have recently died. The soil shows an abundance of available nitrogen. The complete analysis of this sample has not yet been made. No. 176 is also a sample of the prairie soil around Olympia. It contains a very large amount of nitrogen, 75 per cent. of which is contained in the humus.

SNOHOMISH COUNTY.

No. 103 is from near Port Gardner, and is described as poor land upon which nothing can be raised without the use of fertilizers. It shows a very low percentage of nitrogen in the humus, No. 177 is from Cedarhome and is described as being from an old burn, all full of ferns, that will not produce grain. Grows good crops of red clover and alsike for about three years, and after plowing and seeding to clover and alsike again, it produces very small crops. This soil is undoubtedly suffering for want of nitrogen. The percentage of nitrogen in the humus is the lowest I have observed. A re-determination served to confirm the accuracy of the analysis. The supply of total nitrogen is fair, but only 15 per cent. of it is organic.

	Island County		Clallam County	Clarke County	Pierce County
	105	122	111	162	37
Humus.....	51.000	3.341	1.340	3.885	.710
Total Nitrogen in soil.....	1.576	.230	.210	.189	.016
Organic Nitrogen in soil.....	1.234	.146	.030	.106	.008
Nitrogen in humus.....	2.420	4.360	2.250	2.738	1.110
Phosphoric Acid.....	.009		.036	.079	
Organic matter	79.217	11.810	7.233	12.350	4.320
Phosphoric Acid (P_2O_5).....	.067	.344	.240	.137	.205
Lime.....(CaO).....	.564	1.214	.524	.333	.569
Potash.....(K_2O).....	.145	.625	.154	.335	.003
Iron Peroxid.....(Fe_2O_3).....	.181	4.105	5.094	10.531	3.557

ISLAND COUNTY.

No. 105 is peat soil such as is used for agricultural purposes near Livingston Bay. It does not produce well. While the organic nitrogen in this peat is nearly 80 per cent. of the total, still it constitutes a little less than 2.5 per cent. of the humus. Such a soil however, with 1.234 per cent. available nitrogen cannot well be deficient in that element. No. 122 is from Whidby Island and is theoretically the strongest soil in every respect that we have analysed from Western Washington. Its nitrogen content is excellent, about 60 per cent. of it being organic. It is a productive soil and is growing fruit successfully.

CLALLAM COUNTY.

No. 111 is from Port Angeles. It is a virgin soil. Its available nitrogen is low and this explains the exceedingly beneficial

results of stable manure when applied to the soils in this vicinity. The organic nitrogen is less than 15 per cent. of the total.

CLARKE COUNTY.

No. 162 was sent from Fisher. Its nitrogen content is good.

PIERCE COUNTY.

No. 37 is from Fern Hill. It is a weak soil in every respect save in phosphoric acid. Its total nitrogen is very small (50 per cent. of it being available) and the organic nitrogen is only 1 per cent. of the humus. It is described as a poor soil.

As mentioned in the preceding pages there exists a striking relation between some of these analytical results. In many instances the result of multiplying the percentage of total soil nitrogen by 55 and dividing the product by the percentage of humus gives a figure which approximates closely to the percentage of nitrogen in the humus as determined by analysis. Stated in a simpler form, in these cases the organic or humic nitrogen is 55 per cent. of the total nitrogen. We state the relation in the more complex form because the standard has been made by Hilgard in percentage of nitrogen in the humus. The relation is expressed by the formula $C = \frac{b \times 55}{a}$ where C = percentage of nitrogen in humus; b = percentage of total soil nitrogen; a = percentage of humus. To facilitate comparison we summarize the soils discussed, giving humus, total nitrogen, organic nitrogen, nitrogen in humus, ratio of organic to total nitrogen, and the result of applying the above formula.

Serial No.	Percent- age of Humus in Soil	Percent- age of Nitrogen in Humus	$C = \frac{b \times 55}{a}$	Percent- age of Total Nitrogen in Soil	Percent- age of Organic Nitrogen in Soil	Percent- age of Organic Nitrogen of Total Nitrogen	Percent- age of Phos- phoric Acid in Humus	Percent- age of Phos- phoric Acid in Soil	Percentage of Phos- phoric Acid in Hu- mus of Total Phos- phoric Acid
30	2.760	5.000	2.272	.154	.138	89.6		.265	
114	1.469	4.830	4.905	.131	.071	54.2		.096	
115	.182	2.160	3.290	.012	.004	33.3	.009	.153	5.88
119	3.300	7.760	5.583	.335	.256	76.4	.043	.070	61.40
120	3.170	6.760	7.183	.414	.214	51.7	.029	.096	30.20
37	.710	1.110	1.240	.016	.008	50.0			
184	3.822	3.120	2.719	.189	.119	62.9			
42	1.648	1.195	5.773	.173	.020	11.5	.001	.109	.92
43	.420	4.220	13.360	.102	.018	17.6		.085	
175	5.010	3.366	2.119	.193	.169	87.5	.014	.089	15.70
44	29.810	3.734	4.039	2.189	1.111	50.7	.029	.105	27.62
45	3.570	2.732	3.762	.244	.097	39.8	.075	.365	20.56
46	1.062	3.980	3.677	.071	.021	29.6	.105	.273	38.46
71	.520	3.410	8.356	.079	.018	22.8	.005	.112	4.46
74	1.490	2.500	1.883	.051	.037	72.5		.288	
76	2.900	1.900	4.855	.256	.055	21.5		.096	
77	1.222	5.160	4.591	.102	.063	61.8		.112	
5	.850	2.780	7.118	.110	.024	21.8		.142	
72	2.486	2.390	3.479	.173	.059	34.1	.063	.361	17.45
73	1.190	1.490	6.055	.151	.018	11.9	.036	.121	30.00
75	3.292	2.180	3.800	.250	.072	28.8	.077	.294	26.19
78	23.450	4.013	2.495	1.064	.904	84.9	.208	.285	73.00
79	2.828	2.055	3.218	.182	.058	31.8	.054	.067	80.60
139	1.450	4.890	5.841	.154	.071	46.2	.036	.139	25.90
140	2.314	2.890	4.373	.184	.067	36.4	.063	.084	75.00
141	.386	3.980	2.850	.020	.015	75.0	.017	.144	11.80
142	2.050	6.530	5.463	.204	.134	65.7	.085	.265	32.08

Serial No.	Percent- age of Humus in Soil	Percent- age of Nitrogen in Humus	$C = \frac{b \times 55}{a}$	Percent- age of Total Nitrogen in Soil	Percent- age of Organic Nitrogen in Soil	Percent- age of Organic Nitrogen of Total Nitrogen	Percent- age of Phos- phoric Acid in Humus	Percent- age of Phos- phoric Acid in Soil	Percentage of Phos- phoric Acid in Hu- mus of Total Phos- phoric Acid
80	32.150	1.420	2.088	1.221	.460	37.7	.009	.048	18.75
81	.432	2.736	7.512	.059	.012	20.3	.003	.019	15.79
124	.780	4.390	6.910	.098	.034	34.7	.014	.026	53.85
126	1.120	8.003	4.518	.092	.089	96.7	.028	.045	62.22
82	.600	6.895	13.020	.142	.041	28.8	.015	.089	16.85
83	.180	12.040	31.170	.102	.022	21.5	trace	.070	
84	.250	8.668	11.220	.051	.022	43.1	.006	.045	13.33
85	.328	8.410	13.250	.079	.028	35.4	.013	.144	9.03
86	.596	6.940	17.070	.185	.041	22.2	.015	.267	5.61
100	2.990	5.600	5.647	.307	.167	54.4	.068	.304	22.36
101	2.740	10.460	7.346	.366	.287	78.4	.018	.205	8.78
91	.084	4.700	38.630	.059	.004	6.8	.010	.128	7.81
92	.128	3.080	21.910	.051	.004	7.8	.004	.174	2.30
93	.148	2.660	11.900	.032	.004	12.5	.010	.141	7.09
94	.182	4.330	16.620	.055	.008	14.5	.003	.153	1.96
137	.150	6.570	11.730	.032	.010	31.3	.008	.029	30.70
102	2.640	6.050	5.604	.269	.160	59.5		.057	
129	.690	7.190	5.340	.067	.050	74.6		.070	
179	18.100	2.228	1.554	.512	.403	78.7		.390	
176	5.793	5.373	3.864	.407	.311	76.4		.320	
103	3.006	1.311	2.628	.158	.039	24.7	.047	.176	26.70
177	2.150	.918	3.530	.138	.020	14.5		.237	
105	51.000	2.420	1.700	1.576	1.234	78.3	.009	.067	18.43
122	3.341	4.360	3.786	.230	.146	63.5		.344	
111	1.340	2.250	8.620	.210	.030	14.3	.036	.240	15.00
162	3.885	2.738	2.676	.189	.106	56.1	.079	.137	57.60

In the following table, the soils examined are classified in three groups. The first group contains those soils in which the application of the above formula produces results which are within 1 per cent. of the percentage of nitrogen in the humus as determined by analysis. The second group includes those soils where the variation is greater than 1 and less than 2 per cent. In the third group are found those soils in which the variations are greater than 2 per cent. There are nineteen samples in the first group, ten in the second, and twenty-four in the third.

Serial No.	Percent- age of Nitrogen in Humus	$C = \frac{b \times 55}{a}$	Serial No.	Percentage of Nitrogen in Humus	$C = \frac{b \times 55}{a}$	Serial No.	Percentage of Nitrogen in Humus	$C = \frac{b \times 55}{a}$
114	4.830	4.905	175	3.366	2.119	119	7.760	5.583
37	1.110	1.240	78	4.013	2.495	30	5.000	2.272
184	3.120	2.719	141	3.980	2.850	101	10.460	7.346
44	3.734	4.039	129	7.190	5.340	42	1.195	5.773
46	3.980	3.677	176	5.373	3.864	43	4.220	13.360
74	2.500	1.883	75	2.180	3.800	71	3.410	8.356
77	5.160	4.591	79	2.055	3.218	76	1.900	4.855
142	6.530	5.463	103	1.311	2.628	5	2.780	7.118
80	1.420	2.088	115	2.160	3.290	73	1.490	6.055
100	5.600	5.647	140	2.890	4.373	81	2.736	7.512
102	6.050	5.604				124	4.390	6.910
179	2.228	1.554				126	8.003	4.518
105	2.420	1.700				91	4.700	38.630
122	4.360	3.786				92	3.080	21.910
162	2.738	2.676				93	2.660	11.900
120	6.760	7.183				94	4.330	16.620
45	2.732	3.762				137	6.570	11.730
139	4.890	5.841				177	.918	3.530
72	2.390	3.479				111	2.250	8.620
						82	6.895	13.020
						83	12.040	31.170
						84	8.668	11.220
						85	8.410	13.250
						86	6.940	17.070

We simply state this relation as we have found it in nineteen cases out of fifty-three, without attempting to draw any conclusions from it. It is a very important fact however that all but three (Nos. 45, 100 and 102) of the samples in the first group, are virgin soils. In the second group No. 115 is a sub-soil, and all the rest are virgin soils. In the third group Nos. 119, 30, 101, 71, 73, 81, 124, 126, are soils that have been under cultivation for some time. Nos. 42 and 43 come from a region of 100 inches annual rainfall. Nos. 91, 92, 93, 94 and 137 are arid soils in which the humus is less than 0.2 per cent. No. 177 is from an old burn. Nos. 82, 83, 84, 85 and 86 are tide lands. *It is more than probable that if there were a definite relation in normal soils between the total and organic nitrogen, it would not hold for any of the soils in the third group except Nos 5, 76 and 111.*

We expect to continue our work along the line discussed, and believe further investigations will show that there is at least as definite a relation between the total and organic nitrogen in *normal* soils, as there is between the organic nitrogen and the humus.



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THE ACID TEST FOR MILK AND CREAM

By W. J. Spillman

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THE ACID TEST FOR MILK AND CREAM

By W. J. Spillman

THE CAUSE OF THE DEVELOPMENT OF ACID IN MILK.

The sourness of sour milk is due to the presence of lactic acid. This acid is formed from the milk sugar, or lactose, always present in milk, there being usually about 5 lbs. of lactose in 100 lbs. of milk. The formation of lactic acid begins immediately after the milk is drawn, but milk does not smell or taste sour until the amount of acid present amounts to about three-tenths to four-tenths of one per cent. The milk coagulates or clabbers with a slight increase of acid beyond this point. Heat aids coagulation ; so much so that milk containing less than three-tenths per cent. may coagulate when heated nearly to the boiling point.

The conversion of milk sugar into lactic acid is done by bacteria, which are minute vegetable organisms that get into milk from the air, from small particles of dried manure falling from the cow's flanks and udder during milking, and from the milk vessels themselves, especially if the vessels are not well washed and scalded. Some kinds of bacteria are desirable in milk that is to be made into butter or cheese ; in fact, they are necessary ; but on account of their rapid increase in numbers the milk must be carefully and intelligently handled in order that these little friends of the dairyman may not do more damage than they do good. These bacteria cause many other changes in milk, but further discussion of this subject must be reserved for another place.

NECESSITY OF SUCH A TEST.

In handling milk and cream it is often desirable, and indeed frequently necessary in order to secure satisfactory results, to know how far the work of these bacteria has proceeded; for instance, it has been found that if cream is allowed to get too ripe, the flavor of the butter is injured, while if churned too sweet, there is a heavy loss of fat in the butter milk, unless extra precautions are taken to churn at a lower temperature than usual. Again, it is a well known fact that if milk be heated when just on the point of souring, it will coagulate; now milk is usually heated before being run through the separator, and milk that is nearly sour will give great trouble and loss by clogging up the separator, besides being sure to sour immediately and spoil all the milk in the skim milk vat. In making cheese too, we must have milk that is not any where near turning, in order to make a fine quality of cheese, and if we wish to pasteurize (kill the bacteria by heat) milk or cream so as to keep it several days or send it to distant customers, we must have the very sweetest milk to work with. It has been found in practice that the acidity, or sourness of milk, is a very reliable index of its bacteriological condition.

It is therefore very desirable to have some simple means of determining the acidity of milk and cream at all stages of their history, from the milk pail to the churn or cheese vat, or pasteurizing room. The acid test does this, and it is so simple that any one can learn the process in a few minutes, while the test itself requires only the simplest apparatus and a few seconds time in its manipulation.

USES.

The acid test is useful in two ways:

1. It enables us to select pure, sweet milk for pasteurizing, for cheese making, for running through the separator, and for sending to market.
2. It enables us to control the ripening of cream in such a manner as to have the cream exactly ready to churn when we are ready for it. Suppose we find, for instance, that in the evening our cream contains five-tenths per cent. acid. We know that it is ripening too fast, and we cool it so that fermentation will pro-

ceed very slowly over night. If we find the cream very sweet at evening, we warm it up so as to hasten the ripening process, and thus have it ready for churning in the morning.

AMOUNT OF ACID AT DIFFERENT STAGES.

Fresh milk usually shows some acid present when tested. For all practical purposes milk is perfectly sweet when the amount of acid is not above twelve to fifteen-hundredths of one per cent. (.12-.15%). In selecting milk or cream for pasteurizing, or milk for separating, two-tenths per cent. has been taken as the highest permissible acidity.

As above stated, milk or cream does not smell or taste sour until the acidity amounts to three-tenths to four-tenths per cent.

The acidity of cream when ready to churn is usually between five-tenths and seven-tenths per cent. If the acidity be lower than about five-tenths per cent., the butter will lack in flavor, and there is liable to be great loss of fat in the buttermilk. If above seven-tenths per cent. the butter may have undesirable flavors.

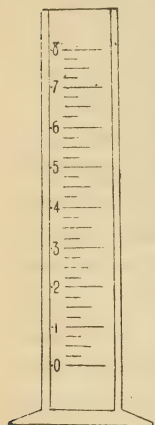
Like many other bacteria the bacteria of lactic acid cease to act after they have produced a given amount of change. The products of their own growth seem to be injurious to them. When the acidity reaches about one and three-tenths per cent. the milk becomes so sour that the bacteria which caused the sourness cease to grow. Hence this is about the limit of acidity under normal conditions.

After the acidity of milk or cream reaches about seven-tenths to eight-tenths per cent. the character of the bacterial action seems to change somewhat. Other constituents than the milk sugar are attacked, probably by bacteria that have remained comparatively dormant until this time, and the result is the development of flavors and odors that are often very undesirable.

DIRECTIONS FOR MAKING THE TEST.

Apparatus. The acid test graduate shown in the accompanying figure is the only special piece of apparatus necessary in making the test. This was devised by the writer, and has been in use during the past year in our College creamery. This graduate is made by the Creamery Package Manufacturing Co.,

Chicago. In addition to this all that is needed is a common prescription bottle of six or eight ounce capacity, and a package of Farrington's Alkaline Tablets. Fill the bottle with water and add one tablet for each ounce of water in the bottle. Shake the bottle frequently to aid in dissolving the tablets. It takes some time for them to dissolve. Prof. E. H. Farrington of the Wisconsin Dairy School, who devised the tablets, recommends that the tablets and water be placed in the bottle at night; the solution will then be ready for use next morning. The tablet solution loses strength if allowed to stand more than one day. Hence it should be made fresh each day. The tablets must be completely dissolved in the solution, except a flocculent residue that will not dissolve, before any of it is used.



Making the Test. In making the test, the acid test graduate is filled to the zero mark with the milk or cream to be tested. The tablet solution is then added, a little at a time, and the graduate shaken after each addition to thoroughly mix the milk and the tablet solution. In shaking the graduate give it a rotary motion to prevent spilling any of the liquid. Continue adding the tablet solution until a permanent pink color can be detected in the milk. The level of the liquid in the graduate, measured by the scale on the graduate, will then be the per cent. of acidity of the milk.

It is best to stand the graduate on a piece of white paper, so that the first pink coloration of the milk may be easily detected.

PRINCIPLE UPON WHICH THE TEST IS BASED.

When an acid and an alkali are mixed together they neutralize each other. In fact they destroy each other, the materials composing them reuniting so as to form a new set of compounds neither acid or alkaline. There are a number of substances, such as litmus, tumeric and phenolphthalein, that have one color when mixed with an acid, and another when mixed with an alkali. The last named is colorless when placed in a liquid containing acid, and red when in alkali. If now some phenolphthalein be placed in the milk that is to be tested, it produces no color because

the milk contains acid. But if enough alkali be added to neutralize all the acid present and render the milk slightly alkaline the phenolphthalein immediately turns red and gives the milk a pinkish tinge. Knowing the amount of alkali we have added, we have an index of the amount of acid in the milk.

Substances like phenolphthalein, that are used to show when a chemical action ceases, are called indicators. In the acid test as described in this bulletin, the alkaline tablets contain both the alkali and the indicator. They are pinkish in color, and the tablet solution is red. When a small quantity of it is added to milk the solution loses its color entirely. But when enough has been added to neutralize all the acid in the milk, the milk turns slightly pinkish in color. It is one of the nice points of the test to tell exactly when this pink color begins to appear, for as soon as the slightest permanent pink coloration shows, the acid is all neutralized, and no more tablet solution should be added.

PROF. FARRINGTON'S TEST OUTFIT.

The outfit for testing recommended by Prof. Farrington in Wisconsin bulletin 52 is also a very simple and inexpensive one. Instead of the acid test graduate he uses a common tea cup, with a No. 10 cartridge shell for a measure. Put into the tea cup one shell full of the milk to be tested. Then add the tablet solution a shell full at a time. The number of measures of tablet solution that must be used to produce the pink coloration indicates the amount of acid present ; each shell full counting as one-tenth of one per cent.

The same bulletin (Wis. 52) describes another more accurate test outfit, but requiring more apparatus and manipulation. It is believed that the two outfits described above, however, are sufficient to meet the needs of the dairymen of the state. They are both perfectly simple ; the first is more accurate than the second, but on the other hand the graduate would probably cost a few cents more than the tea cup and cartridge shell of the second. The shell should have a piece of wire soldered to it for a handle.

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3. Report of Farmers' Institute held at Garfield.
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23. Technical Series No. 1. Some notes concerning the nitrogen content of soils and humus.

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EXPERIMENT STATION

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DEPARTMENT OF HORTICULTURE

PRUNING ORCHARD TREES

By J. A. Balmer

DECEMBER, 1896

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PRUNING ORCHARD TREES

By J. A. BALMER

The numerous inquiries by correspondents on the subject of pruning orchard trees, has induced me to offer in bulletin form, a few words of advice on the subject.

That the subject is a live one, is evinced by the keen interest taken in its discussion at farmer's institutes, and that the principles underlying the practice of pruning are very imperfectly understood, is clearly proven by the widely different practices followed by orchardists of the state.

There are those who advocate summer pruning and pinching. They say: "All that is necessary is your finger and thumb, to correct the habit of the young growth, take out all superfluous shoots, leaving only those necessary to the proper formation of a correct system of limbs. Let the knife severely alone."

There are others who believe in severe pruning, and each season, as the time to prune comes around, we find them butchering trees with saw and ax.

There are others who say: "I don't want any pruning done in my orchard, nature knows better than I how to grow a tree, and I prefer to let nature have her way."

It is probable that there will always be a diversity of opinion amongst orchardists as to the best methods and proper time of pruning, and this is hardly to be wondered at, when we consider the immense amount of literature already published on the subject, to say nothing of the diversity of practice which would follow diversity of climatic conditions. One rarely looks at a horticultural paper without finding there the views of some one on pruning fruit trees. Perhaps the writer lives in California, or Canada, or on the Atlantic seaboard. And yet he undertakes to expound a theory, or advocate a practice, that, while it may be admirably adapted to his particular conditions, is totally unsuit-

able for sections of this great country remote from that of the writer.

But what shall the poor amateur do, when authors of unquestioned ability, who undertake to give instruction on a subject which varies so much with the conditions, present such opposite views?

The late A. J. Downing, who, over fifty years ago, wrote his "Fruits and Fruit Trees of America," in presenting a few remarks on pruning said: "In this country almost all fruit trees are grown as standards. In this way they develop their natural forms, attain the largest size, and produce the greatest quantity of fruit with the least possible care. Our bright and powerful sun, reaching every part of the tree, renders the minute systems of pruning and training, which occupy so large a portion of the English works on the subject, of little or no moment to the cultivator here. Pruning is therefore commonly resorted to only for the purpose of increasing the vigor of feeble trees, or to regulate and improve the form of healthy and luxuriant trees. Every fruit tree, grown in the open orchard or garden as a common standard, should be allowed to take its natural form, the whole efforts of the pruner going no further than to take out all weak and crowded branches."

A more recent writer, and one no less famous, the late Patrick Barry, in his "Barry's Fruit Garden" says: "The idea that our bright American sun and clear atmosphere renders pruning an almost unnecessary operation, has not only been inculcated by horticultural writers, but has been acted upon in practice to such an extent, that more than three-fourths of all bearing fruit trees in the country are at this moment either lean, misshapen skeletons, or the heads are perfect masses of wood, unable to yield more than one bushel in ten of fruit, well matured, colored, and ripened."

Here we have two prominent writers, presenting views on pruning totally at variance,

There are a few general principles underlying the practice of pruning which I wish to present before entering into a discussion of the subject in hand.

It is well known that severe pruning at a time of year when the tree is dormant, is conducive to a strong wood growth the

following season. This is based on the principle that if we assume that a certain amount of nourishment is supplied by the roots to all of the branches and buds of a tree, by cutting off one-half of the branches at the proper season we direct the whole supply of nourishment to the remaining portion, which will consequently grow with increased vigor.

On the other hand, if we prune a tree severely in summer, or if by persistent pinching we reduce its foliage by one-half, we sap the very life of the tree. For it is well known that the office of the leaves is to manufacture food for the development of tissue, which goes to build up every part of the tree, and every time we reduce the supply of foliage, we, to a certain extent, cripple or retard the growth of the tree.

Climatic conditions will largely determine what practice we shall adopt in pruning our fruit trees. In a state like Washington, where such dissimilar climatic conditions exist as between the regions west of the Cascades and the regions east of the Cascades, no practice can be laid down that will be applicable to both sides of the range. What would be a perfectly proper practice west of the Cascades, where the sun is obscured a large part of the year, and where the moisture conditions are conducive to a large wood growth, would be almost suicidal on the east side of the range, and *vice versa*. Therefore it will be necessary to adopt a different practice for each side.

Let us first observe the conditions prevailing in Eastern Washington. Here we have a long dry summer, with a fierce scorching sun, and strong drying winds, with a maximum rainfall of probably less than eighteen inches per annum, followed by a severe winter with fluctuating temperature, and sudden changes. In portions of the fruit belt there is barely enough natural moisture in the ground to sustain a tree. Under these conditions who can wonder that trees on the east side come to maturity at an early age, and produce fruit at a time in their lives when they ought to be making wood growth, and establishing a strong, healthy frame for future usefulness. And yet, conditions which at first sight would seem totally unfitted for the production of healthy trees and fine fruit, are, with the aid of intelligent cultivation, and a judicious use of water, made to produce abundantly of the choicest fruits of the earth.

There is no question in my mind, as to what is the proper method to adopt in pruning our fruit trees on the east side of the mountains. *We must prune in winter and prune hard.* The tendency of all our young trees is to run to premature fruiting. Cherries carrying a crop of fruit at two years old, and pears and apples bearing full crops at five and six years old. To overcome this tendency in our trees we must practice a system of pruning



FIG. 1

that is conducive to wood and leaf growth, and to discourage all forms of summer pruning and pinching. The practice of allowing nature to have her sway in our orchards has been tried and found wanting. A tree left to nature's way will soon become a brush-pile in the air. As an illustration of this, we have had photographed two trees at present growing in a neighboring orchard. The trees are seven years old and have never known knife or shears since they were set out.

Figure 1, represents an Early Richmond cherry. Figure 2,

a Green Gage plum. Notice the innumerable branches, all emerging at or near the ground—no trunk (and none is needed in this climate) the entire tree a mass of fruit buds, and woody growth almost suspended. Nature's only effort in these trees seems to be reproduction. These neglected trees teach us a valuable lesson. They say plainer than words, "If you don't cultivate and prune me, I will soon be dead, for I cannot bear this strain, of annually carrying heavy loads of fruit much longer."



FIG. 2

They are making little or no new wood, consequently have little foliage and all the buds being fruit buds, the trees must soon succumb. No, it won't do to let nature have her own way entirely in our orchards. If we would have trees beautiful in outline, with stout short jointed frames, that will carry heavy crops of beautiful fruit, and do it without bending to the ground or splitting the trunk, we must lay the right kind of a foundation, and to do this we must commence with a yearling tree. I specify a yearling

tree, for the reason that if we buy two-year-old trees they have usually been ruined by the nurseryman's knife in following the practice known as trimming up. We don't want trees that have been trimmed up, for the limbs are already lopped off that ought to go to make up the frame of a symmetrical low-headed tree.

I agree with the late Mr. Patrick Barry "That fully three-fourths of all bearing trees are at this moment lean, misshapen skeletons." And probably the per cent. of mismanaged, ungainly fruit trees in our own state to-day is greater than this. The greatest mistake has been made in allowing too much bowl or trunk to our trees at the outset, and in neglect of intelligent use of the knife in the early years of the tree. A young tree with a trunk four or five feet long is in a sad predicament in this part of the state. It is soon in the condition described as hide-bound, sun-burned, and becomes a prey to borers. I take it, there is no one thing that will conduce to success in fruit growing more than will low heading of trees.

On page 154, of his "Fruits of California" Prof. Edward J. Wickson, of Berkeley, California, has this to say of low heading: "The mainspring of success in California is to grow low trees. Low is a term admitting of degrees, it is true, and may imply a trunk of six inches up to one or two feet in the clear. There are old trees with much higher stems, and in some parts of the state they are safe, but few experienced fruit planters now head their trees high.

Low heading has for us all the advantages for which this practice is approved in other parts of the world, viz., accessibility of fruit and ease of pruning, symmetry and solidity, and consequent decrease of danger from high winds, greater facility of approach to the trunk with the horse in cultivation. This last point has been contested on our own soil, for experience has demonstrated that properly trained trees with low heads and obliquely-rising branches are handier for the cultivator than high-headed trees with drooping horizontal branches. But these general advantages of low-trained trees are not the chief ones secured in California in low heading. Hundreds of thousands of trees have been destroyed by the exposure of a long, bare trunk to the rays of the afternoon sun. The sun-burned sides have given the conditions desired by borers, and destruction has quickly followed. Some-

times young trees have not survived their first season in the orchard, because of burned bark; or this, with the added injury by the borers. It is found by California experience that the growth is more vigorous in the branches when they emerge near the ground. Even where actual burning may not occur, the travel of sap through the longer distance of trunk is undesirable. It is believed, also, that benefit results from shading of the ground at the base of the trees, by reducing evaporation, and by maintaining a temperature of soil better suited to vigorous root growth. But whatever may be the reasons, the fact is indisputable, the higher the prevailing summer temperature, and the greater the aridity, the lower should the tree be headed."

In the same work is given the practice and experience of many of the prominent fruit growers of California. And they without exception, all advocate low heading. One of these correspondents, General H. P. Chepman, of Tehema county, says: "I would prefer a head within six inches of the ground. Among my early plantings I can show trees with a clean trunk of four or five feet, and I shall keep a few as monuments of my ignorance; the balance I shall cut down and grub out."

The climatic conditions prevailing in Eastern Washington are similar to those found in many parts of California, except that the California summers are longer and hotter, and of course our winters are more severe. But this does not alter the fact that what has been found a good practice in California will certainly be a wise one to follow here.

The experimental orchard on the station at Pullman, clearly illustrates the advantages of low-heading over high-heading. Amongst the earlier plantings were trees with stems varying from three to five feet in length. The bark on the trunks of these trees looks glazed and burned, the trunk is not developing in proportion to the top, and most of them are bent by the force of the wind, making their condition a more exposed one. Contrasted with these, are trees with their branch system emerging within a foot or eighteen inches of the ground, and whose bark is healthy and natural looking accompanied with a full and perfect development in all parts of the tree. The tall trees are rapidly running to fruit buds, whilst those that have been kept dwarf by the use of the

knife in winter, show a vigor much in advance of their long-legged neighbors.

Low heading then, is the watchword for planters in Eastern Washington. Commence with a yearling tree, switches preferred, for example, fig. 3, for in these we find the entire bud system intact, and we can head our trees at any desired height. All trees that naturally have a tall upright habit of growth, such as apple, pear, and sweet cherry, ought to be headed not higher than twenty to twenty-four inches from the ground. And all stone fruits such as peaches, plums, prunes, apricots, etc., ought to be headed a little lower, say twelve to eighteen inches from the ground. Yearling trees as usually found in the nurseries of the state, will range from

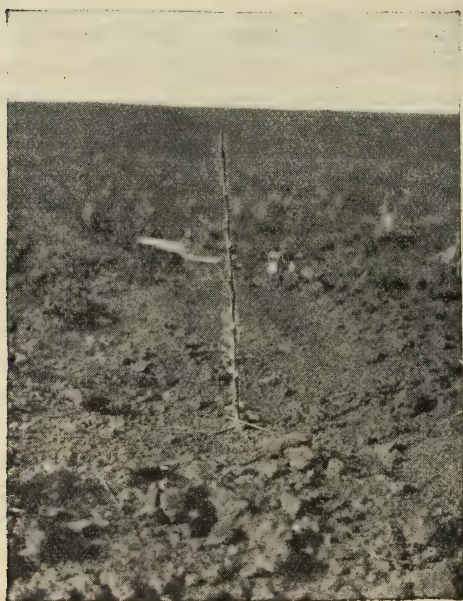


FIG. 3

two to four—or even seven or eight feet high. At planting time, whether it be spring or fall, these ought to be headed down to the proper height.

I am aware that it seems like a great sacrifice to take a strong young tree and cut away three-fourths of its top, but it must be done, and done at once; for if you allow one year to pass without attention to this topping, your chances to secure a well-formed low-headed tree are

lost. For while you may at any time cut a tree back to the desired height, yet, to cut back into wood that is two or three years old, never gives the same results as does attention to this matter at the proper time.

It will be seen that the treatment of the tree the first season is of a very simple nature. Your young orchard contains a lot of

stubs sticking out of the ground, to a height not exceeding two feet. During the first season's growth these stubs will develop numerous branches, almost every bud will start, and what was lately a stub will become a little forest of shoots. Now, if you follow some of the authorities you will, as soon as the young shoots commence to develop, proceed to pinch or rub off all the limbs you don't need to form the frame of the tree. I say, don't pinch or rub off anything. Allow every limb and every leaf to develop to its fullest extent. Remember that the leaves are to a tree what our lungs and blood are to us; its very life. And every leaf you deprive the tree of in summer is robbing it of its tissue-forming organs. Without leaf action there can be no root action. And the fullest development in root and branch can only be secured by religiously preserving the foliage.

The question is often asked when is the proper time to prune? This can only be answered by asking another question, what end are you aiming at? Do you want your trees to bear prematurely, or do you desire the fullest development of tree growth before allowing them to carry heavy loads of fruit? If the former, then pinch and prune in summer; if the latter (and this is certainly the more desirable), prune in winter. The best time to prune is any time after the leaves have fallen in autumn, and before the buds commence to develop in spring.

Care must be exercised, however, not to prune at a time when there is frost in the ground or in the air. If the system of the tree be frozen, all organizable matter is at a standstill, and the wound you make will not readily heal up, and the result may be dead stubs:

We will proceed to prune our tree for the second time. The



FIG. 4

switch that you planted and headed back last year, has developed a number of shoots, maybe five or six, but more often fifteen or twenty. From these select from three to five of the strongest, best ripened limbs (cutting out all the rest) at the same time exercising care to have them evenly fill the space around and above the tree. *Observe carefully that no two limbs emerge from the trunk opposite each other, forming what is known as a crotch.* A crotch in an old tree is always an evil, causing a weak spot where the tree will be likely to break down or split during a heavy fruit crop. The remedy is in your own hands when you go to prune your two-year-old tree, cut out every limb that forms a crotch with its neighbor.

Figure 4 will convey to some the idea of what a two-year-old tree ought to be like after having received its second pruning. Notice the arrangement of the limbs. All crotches have been avoided; from the ground to the lowest branches is twelve inches, the entire height of the tree thirty inches. Contrast this little stocky tree, with the weaklings of the same age one commonly meets in orchards to-day, with thin, misshapen trunk three or four feet high, surmounted by two or three long spindling branches, the whole innocent of knife or shears. No wonder our trees break down, they have not strength to carry a heavy crop of fruit.

After having selected the desired number of limbs intended to form the frame of the tree, shorten these back to within a foot of the trunk, always cutting to a plump prominent bud. The tree may be spread, or it may be contracted, by cutting to a bud which points outward, for the former, and to a bud that inclines inward for the latter. You need not hope to alter the character of the tree by this cutting to a bud, yet a little may be done to improve its shape. As a rule the weaker the growth the harder it ought to be cut back, this will encourage an increased wood growth the following summer. Trees treated in this way make a growth that is often very perplexing to the amateur; the result of this shortening in of all the limbs will be an increased number of shoots to treat the following season.

Figure 5 is inserted to show a tree of the worst form. It is a plum, two years old from the nursery, and has been trimmed up; the trunk is about four feet long, and all the limbs emerge in a

cluster, forming a very weak tree. Notice that the tree is planted inclined several points to the wind, and that the limbs have been cut severely back with a view of stocking up the frame. Unless they are valuable varieties such trees would better be consigned to the rubbish pile.



FIG. 5

Figure 6 shows a cherry tree with a trunk too long. It is inserted mainly to show at what an early age fruit buds are formed.

Figure 7 shows a sweet cherry tree of good form, branched low down. It shows very plainly the tendency to early fruiting in

our trees. The extreme height of this tree is six feet. It has been planted four years, and has been four times pruned.

The third pruning is conducted on the same lines as the second with this difference: Select the limbs you wish to continue the upward growth of the tree; these will usually be not more than two on each of those left last year, observing the same care not to leave crotches, and shortening in the growth made in that season;

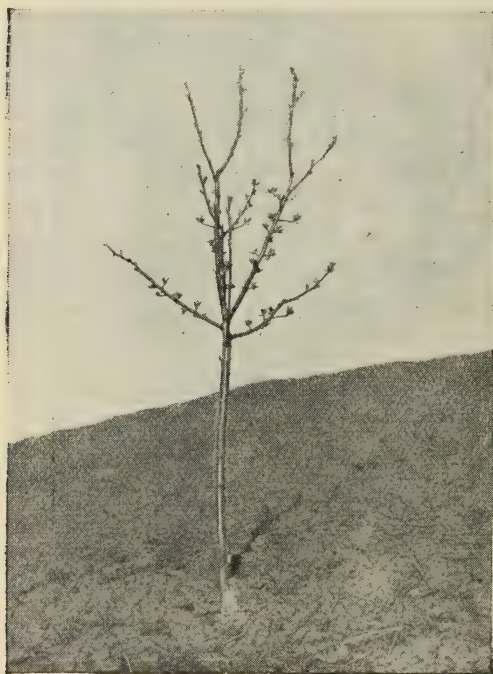


FIG. 6.

How often do we see trees with great quantities of wood entirely devoid of fruit spurs caused by leaving the entire summer's growth and not shortening in the shoots. A tree in this condition is exposed to the same evil influences that affect trees with tall trunks, and the greatest care ought to be exercised to encourage all weak growth and dormant buds to develop a fruiting condition. The third season's pruning, then, differs from the first and second in leaving a part of all the growth instead of taking it clean off as in the case of very young trees. I object to leaving

but instead of taking off all of the inside shoots clean to the branch, they are left an inch or two long, and in the course of a season or two all these stubs that you leave will be converted into fruit spurs. I would practice pruning if for no other reason than to develop every bud on all the limbs, and would treat these buds in such a manner that all would eventually become fruit spurs.

spurs before the third season for the reason that by so doing we encourage a fruiting condition in our trees at too early an age, and this is the very end we are trying to defeat.

The necessary pruning during the following two or three years does not materially differ from that described for the third year. Let the aim be a symmetrical low, somewhat round-headed tree—the top ought not to be too full of wood—and not too thin! Do not expect that every tree can be pruned so as to assume an ideal form, for in this you will be disappointed. No two trees have exactly the same habit of growth. Some are tall and close, others spreading and willowy. All may be vastly improved by an intelligent use of the knife during the early years of the tree's growth.

At the age of four or five years we find cherry, plum, and even apple and pear, rapidly develop-



FIG. 7

ing fruit buds. And as this condition becomes evident the use of the knife had better be gradually discontinued. All the pruning necessary on bearing trees is to encourage a proper development of the leading shoots and if these are making a growth of over twenty-four inches annually, they ought to be shortened in to encourage a stocky habit of tree. All weak shoots appearing lower down on the tree should be cut back to within an inch or two of

the limbs, thereby forming a full and correct system of fruit spurs on every part of the tree.

Water sprouts, as they are usually termed, are simply evidence of excessive vigor in a tree and, in many cases, ought to be encouraged instead of being pulled off, as is the general practice. We have been able to protect the trunks of many trees in the college orchard by leaving one or two of these sprouts that happened



FIG. 8.

to develop low down on the sunny side of the trunk.

Figure 8 illustrates this practice. An apple that has received its third pruning, and where a sprout has been left to develop leaves with the object of shading and protecting the trunk. And so effectually have these sprouts done their work, that in trees thus treated the bark on the trunk has assumed its proper color and a fuller, more perfect development of the tree has been the result. A shoot left for this purpose ought to be kept within

bounds by pinching and close pruning. After the tree has sufficient spread of top to effectually shade the trunk these side sprouts may be dispensed with.

A tree bent out of shape by carrying large quantities of fruit may, many a time, have its top renewed and the open spaces filled in by using one of these sprouts, and treating it exactly as described for a one and two year old tree. Grow a young tree top of an old one as it were.



FIG. 9.

Figure 9 will illustrate a tree after having received its second pruning, by a timid pruner, and where the growth has been left too long. Of course the reader will understand that it is impossible to lay down a rule that will be applicable in all cases, trees vary so in their habit of growth, and in time of maturing. A system of pruning that might be followed in the case of a Northern Spy apple would not answer in the case of

a Wagener, a Wealthy or a Ben Davis, the former requiring eight or ten years before arriving at maturity, while the latter trees fruit freely at three and four years old. Discontinue the knife as the tree decreases in wood development, until at four or five years, as in the case of early maturing trees, or at seven or eight years as in the case of late maturing trees, you finally drop pruning altogether.

IN WESTERN WASHINGTON

The above practice is recommended for all regions east of the Cascades. Trees on the west of the mountains should be treated a little differently. In most sections on the west side, and especially in the warmer valleys, trees make an extraordinary wood growth. It is no uncommon thing to find young prunes and cherries making a growth of six to ten feet in a single season. The excessive moisture in soil and atmosphere, and the mild climate, is conducive of this rapid growth. Trees grow late in the season, and there is some difficulty in securing thoroughly ripened wood. To cut back severely in winter aggravates the evil, more and longer wood is the result. The way to check this excessive growth is to resort to summer pruning and pinching and even to root pruning.

As it was said at the beginning of this paper, to deprive a tree of a large part of its foliage in summer is to check its exuberance, and encourage a habit of fruitfulness, and here, where vegetation runs riot in the orchard, it might be perfectly proper to resort to a system of summer pruning. For it must be borne in mind we are not growing orchards for timber purposes, but for the fruit they will produce,

To properly carry out the practice of summer pruning, one would better commence with a yearling tree, and head it low. Low heading has all the advantages on the west side that it has on the east side of the mountains, and enough has already been said on this subject to convince the most skeptical. We find nowhere in nature such unseemly conditions as are found in "trimmed up" orchards. A seedling tree in an isolated position is always branched low; only in forests of some age, do we find bare trunks, and these are protected from the fierce sun-rays by the canopy of leaves overhead. The young growth that appears in a clearing is always a thicket, fully branched and protected to the ground. Then why should we do anything so unnatural as go into an orchard and trim off all the lower branches?

Head your young trees back to the desired height, and as growth advances in summer, constantly regulate the same by pinching or cutting off all limbs not required to form the frame of the tree. By allowing the growth to develop three or four inches then pinch back to two inches; the result will be fruit spurs. Of

course it will not do to pinch too much, a certain amount of leaf-growth must be encouraged, only leaders, i. e. limbs intended to form the frame, should be left unpinched, but all laterals ought to be pinched until they have developed a habit of forming fruit buds.

The winter treatment of such a tree would be to shorten back the leaders to within a foot or eighteen inches of last year's growth. By so doing you get rid of all immature growth, and force the remaining buds to develop limbs which (except the leaders) are treated exactly as recommended for laterals. By closely following out this practice you develop a tree fruitful in every limb, feathered to the ground, with no superfluous wood, and no exposed trunk or limbs.

ROOT PRUNING.

Root pruning has the same effect as summer pruning. Where trees have been neglected and are now several years old, yet showing no tendency to fruit, they may be root pruned. This is accomplished by digging a trench, a spade wide, all around the tree at a radius of six or seven feet from the trunk. If the trench be two or three feet deep, most of the horizontal roots will be cut through. Fill in the trench with well pulverized soil, and the result will be a check to the woody growth, the tree having been deprived of a large quantity of its feeding roots, will make less wood and more fruit buds. Root pruning ought to be performed in winter only, and that during mild weather. It is a practice that I cannot generally recommend, for it is rarely ever well done, and moreover it is laborious work and as the same ends may be attained by summer pruning and pinching, it will not generally be practiced.

Planters on the west side of Washington can do much to promote fruitfulness in their trees by a proper selection of soil and location, always remembering that a dry porous soil is conducive to fruitfulness, and mature wood.

REMOVING LARGE LIMBS.

Where large limbs are to be removed from a tree, the work would be better performed at a time of year when there is no foliage in the way. Commence by sawing an inch or so upward from the underside of the branch, then saw from above down; by adopt-

ing this method you will avoid splitting or slivering the bark. All limbs of a larger diameter than an inch, ought to have the wounds dressed with some material to protect the trunk while the wound is healing over. Common paint will answer the purpose. Axle grease is sometimes employed; but gum shellac dissolved in alcohol is probably the best dressing to employ. The material ought to be of the consistency of thin mucilage and when not in use, kept tightly corked to prevent evaporation.

RENEWING OLD TREES.

There are few orchards in the state where the trees are so old that they require cutting over to renew the heads. Yet there are many trees that at present are mere skeletons, which might be benefited by cutting back to encourage a new top. This is done in winter, and consists in sawing off all the tall straggling top. If the tree be still vigorous, it will develop strong young shoots the first year, which should be treated in all respects as if they were young trees. By this method one may convert an otherwise worthless tree into one of usefulness. The better plan, however, would be to grub out all worthless trees, and commence anew with young thrifty stock.

GATHERING UP PRUNINGS.

A matter in connection with pruning, and one which should always have the closest attention is that of gathering up the prunings. These are oftentimes the harbor of aphid eggs, and the eggs of other injurious insects, and if left lying on the ground too long these eggs may hatch and do a great amount of damage. Our practice is to rake up the prunings into bunches and load them into a wagon to be hauled away and burned.

In parts of California where they have very large orchards, a kind of portable furnace is used; this is a large sheet-iron receptacle mounted on four wheels, with an iron frame. In the center of the iron trough is a grate. On this a fire is lit, and the prunings having been previously raked, with a horse rake, into rows, are loaded on to this fire. A horse is hitched to this portable furnace, and the whole orchard gone over, the fire being kept up all the while. This is said to work well in vineyards, but may be too cumbersome for our Washington orchards. At all events, see to it that the prunings are burned and the ashes returned to the orchard.

BEST FORM OF TREE.

A Correspondent recently wrote inquiring if it would not be practicable and profitable to train our trees as *Espaliers* and *Cordons*, as is practiced in England and on the continent of Europe.

These practices are resorted to in the above mentioned countries only where labor is plentiful, and where the planter or proprietor has a good long purse, and is able to employ the necessary help. *Espalier*, *Cordon*, *Fan*, or any of these fancy, and sometimes beautiful forms of tree training, can only be carried on where there are fences, walls or, buildings on which to grow the trees. The extra labor of tying, nailing, and the removal of breast-wood in summer, precludes our adopting the practice here where we have no cheap labor, nor the skilled help necessary to carry out the practice in its fullest detail. Besides in a country like this, where trees grown as low standards, develop so grandly, and fulfilling all the purposes of a fruit tree, we have no need of any other method than the one at present followed. As at present practiced, fruit-growing is none too profitable, and if we were to add to this the extra cost of tree training not to mention the consequent reduced fruiting surface, we would soon find ourselves in the small end of the financial horn.

A CHAPTER ON TRANSPLANTING AND PRUNING ORNAMENTAL TREES.

In a new state like Washington where so many people are establishing homes, many of them on the treeless prairies, there is considerable activity in the line of tree planting, and in beautifying the home surroundings. This is as it should be, and to the end that their efforts may be crowned with greater success are these few words of advice offered.

Transplanting may be done in either Autumn or Spring, Autumn preferred. Trees planted in the fall have time to become well settled in the ground, and the wounded roots have ample time to callous over and throw out new rootlets by the time spring opens. We make an exception in the case of evergreens. These are better transplanted just as spring is fairly opening. When the leaves of the maple are beginning to unfold, is a good time to transplant evergreens. See to it that their roots never become real dry or their chances to live will be much reduced. In all

events the wood of deciduous trees ought to be fully matured and the leaves off. If the tree to be moved is of considerable age, it will be necessary to dig quite a large hole around it, with a view of preserving the greatest amount of roots, yet no matter how well the digging is done, a large quantity of the most valuable feeding roots will always remain in the ground. To compensate for this great loss of root, the top must also be cut away in as great or greater proportion.



FIG. 10.

Figure 10. An English or Cork-barked Maple (*Acer Campêtre*), and Figure 11, a Flowering Ash (*Fraxinus Ornus*), are introduced to show the method of heading-in at transplanting time. The newly transplanted tree having no working roots cannot support a large amount of top, consequently all the wood that can well be spared had better be cut away.

Where it is possible, trees are better if procured at a nursery where they have had cultivation, and attention has been paid to transplanting them. Such trees will have a mass of fibrous roots, and will be in better shape to stand transportation and transplanting than will trees that are dug in timber cultures, or taken from the wilds.



FIG. 11.

taking off the lower limbs, (if this is necessary) when the top is large and spreading enough to shade and protect the trunk. In our dry climate too much importance cannot be attached to this point.

Evaporation is exceedingly rapid and many hundreds of otherwise healthy shade trees, have died from exposure of their trunks to the scorching sun rays.

Trees intended for shade and ornament, should not be hacked and cut out of all natural semblance to their true forms. It is rarely ever necessary to again resort to pruning most of our shade trees after they are once firmly established in their permanent positions. It is quite proper to trim hedges, and some forms of shrubbery into shape, but trees ought to be allowed to take their natural form and habit. The practice of pollarding, *i. e.* trimming of the entire top of shade trees in summer is particularly to be condemned as this cripples and retards their progress. There are cases where the saw could be used to remove an unsightly limb, or correct some uneven growth, but for the most part, nature ought to be allowed to follow her bent in our shade trees.

Where it is possible, it will be found to be a great protection to the tree if the branches can be left as low down on the trunk as possible only

FRUIT TREE CATALOGUE.

List of varieties at present (November, 1896) represented in the Experiment Station orchard.

The following list of varieties of fruit are at present growing on the station. It is the desire of the management to add to this list as fast as opportunities occur. It is particularly requested that those interested in fruit growing will look carefully over the list, and if they are in possession of any varieties of merit, not here listed, I will be glad to open up a correspondence with a view of exchanging.

The orchard is young, and some of the varieties are hardly established yet, most of the trees however are in good vigor and I will take pleasure in sending scions to people that are interested.

APPLES.

Alexander	Colfax	Huntsman's Favorite
Amassia	Canada Reinette	Hoover
Am. Summer Pearmain	Duchess of Oldenberg	Hibernal
Anisette	Duke of Devonshire	Hubbardston's Nonesuch
Aport	Dutch Mignonne	Holland Pippin
Arabskoe	Denvers Sweet	Jersey Sweeting
Arkansas Beauty	Delaware Red	Jefferies
Arkansas Black	Dominie	Jonathan
Autumn Strawberry	Early Strawberry	Keiv Reinette
Baldwin	Early Harvest	Kenozi
Bailey's Sweeting	Early Ripe	Kronish Rosy
Beauty of Kent	English Golden Russet	King
Belle de Booskoop	Fink	Keswick Codlin
Benton	Fameuse	Kay
Benoni	Fallawater	Lead
Ben Davis	Gypsy Girl	Lankford
Blue Pearmain	Gideon	Lady
Borovinka	Golden Sweet	Lowell
Bogdanoff	Golden Russet	Longfield
Boiken	Green Crimean	Ladies Sweeting
Bottle Greaning	Gros Mogul	Lawver
Blushed Calville	Gloria Mundi	Limbirtwig
Buda	Golden Pippin	Mann
Burlington	Golden Reinette	Marion Co. Red
Buckingham	Gano	Mirror
Court Pendu Plat	Gavenstein	Mother
Cooper's Market	Grime's Golden	Maiden's Blush
Cardinal Celina	Haas	McIntosh Red
Chenango Strawberry	Hide's King	McMahon's White

Munson's Sweet	Red June	Tetofsky
Missouri Pippin	Rome Beauty	Talman's Sweeting
Marshall Red	Ribston Pippin	Twenty oz. Pippin
Noble Sovarie	Russian Gravenstein	Violet
Nickajack	Romna	Virginia Greening
Northern Spy	Rambo	White Bellflower
Northwestern Greening	Red Beitigheimer	White Pippin
Ostrokoff	Red Cheek Pippin	Winter Citron
Ortley	Red Canada	Wagener
Palouse	Sabadkia Sertchika	Winesap
Paradise Winter Sweet	Skinner's Pippin	William's Favorite
Peck's Pleasant	Stark, Swaar	Whitney No. 20
Pride of Washington	Sklanka Bogdanoff	Winter Fameuse
Princess Louise	Saxon Priest	Wallbridge
Peter	Smith's Cider	Wolf River
Pryor's Red	Sops of Wine	Willow Twig
Ponyik	Seek No Further	White Astrachan
Pewaukee	Sweet Bough	White Winter Pearmain
Perry Russet	Swinsovka	Wealthy
Red Queen	Simbrisk	White Pelikanoff
Rosy Repka	Sweet June	Windsor Chief
Red Astrachan	Spitzenburgh	Washington
Rosemary	Salome	Yellow Arcade
Roxborough Russet	Summer (Pogatch)	Yellow Bellflower
Reinette de Caux	Shirk	York Imperial
Rambour Queen	Skruschapfel	Yellow Calville
Revel Pear	Steptoe	Yellow Newton Pippin
Rawle's Janet	Stump	Yellow Transparent
Rhode Island Greening		

CRABAPPLE.

General Grant	Montreal Beauty	Transcendent
Hyslop	Paul's Imperial	Van Wyck
Marengo	Red Siberian	Whitney
	Yellow Siberian	

CHERRIES.

Black Tartarian	Dyehouse	Large-fruited Montmorency
Belle Magnifique	Early Richmond	Lewelling (Black Repub.)
Bing	Empress Eugenie	Late Duke
Bessarabian	Elton	Markirsch
Beaader	Early Morello	May Duke
Brusseler Braune	Frassendorfer Weischel	Montmorency
Carnation	Governor Wood	Napoleon Bigarreau
Cerise de ostheim	Griotte du Nord	(Royal Ann.)
Centennial	Heart Shaped Weischel	Orange Kirsche
Double Natte	June Morello	

Ostheim	Reine Hortense	Spate Morello
Orel Sweet	Rocky Mountain	Wagner
Olivet	Rockport	Wragg
Ohio Beauty	Schmidt's Bigarreau	Yellow Spanish
Ostheimer Weichsel		

PEARS.

Andre Desportes	Doyenne du Comice	Longworth
Beurre Diel	Dt. Reeder	Lawrence
Beurre Superfin	Deerborn's Seedling	Leconte
Beurre Gris d'Hiver	Doyenne D'Ete	Lawson
B. S. Fox	Duchess d'Angouleme	Louise Bonne of Jersey
Bartlett	Exeter	Moscow
Beurre Clairgeau	Early Madaline	Mt. Vernon
Beurre Bosc	Easter Beurre	Onondago
Brockworth Park	Early Bergamotte	Pound
Belle Lucrative	Emile de Heyst	Paradise d' Automne
Beurre d'Anjou	Forreile	Peffer No. 2
Beurre Gifford	Frederick Clapp	P. Barry
Beurre Hardy	Flemish Beauty	Seckel
Bloodgood	Gray Doyenne	Souv de Congress
Cole's Seedles	Gansell's Bergamotte	Saccharine
Calvin	Gakousky	Tyson
Clapp's Favorite	Idaho	Urbaniste
Chinese de Ewgery	Jaminette	Victorina
Crassare Bergamotte	Jargonelle	White Doyenne
Columbia	Josephine de Malines	Wilder
Doyenne d'Alencon	Jean de Witte.	Winter Nellis
Doyenne Boussock	Kurskaya	Zoe
Dix	Kieffer	

PLUMS AND PRUNES.

Bradshaw	Golden Prune	Myrobolan
Beauty of Naples	Griotte Precoe	Niagara
Chippawa	Golden Beauty	Ogon
Columbia	Hawkeye	Pissardi
Coe's Golden Drop	Hungarian Prune	Prince Imperial
Communia	Hunt	Peach
Cheney	Italian Prune	Reine Claud Violette
Duane's Purple	Kelsey	Petite d' Agen. Prune
De Sota	Korai Quetsche	Pond's Seedling
Dt. Uff	Lombard	Polish Mirabelle
Eaton's	Long Red	Pottawattamie
Early Rose	Marquoketa	Quaker Beauty
Forest Rose	Mirabelle	Richland
Garfield	Mistake	Saratoge
Geuii	Moor's Artic	Smith's Orleans

Silver Prune	Throop No. 2	Wolfe
Shipper's Pride	Tennant	Wyant
Simonii	Trabesche	White Egg
Spaulding	Throop No. 1	White Queen
Stark's Green Gage	Unarish Prune	White Nicholas
Tragedy	Wild Goose	

WASHINGTON STATE AGRICULTURAL COLLEGE AND
SCHOOL OF SCIENCE.

EXPERIMENT STATION,

PULLMAN, WASHINGTON.

BULLETIN 26.

DEPARTMENT OF CHEMISTRY.

EXPERIMENTS IN THE CULTURE OF THE SUGAR BEET
IN WASHINGTON FOR 1895 AND 1896.

BY ELTON FULMER, A. M.

December, 1896.

All Bulletins of this Station sent free to citizens of the State on
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THE AGRICULTURAL EXPERIMENT STATION.

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EXPERIMENTS IN THE CULTURE OF THE SUGAR BEET IN WASHINGTON FOR 1895 AND 1896.

BY ELTON FULMER, A. M.

The experiments with sugar beets that were carried on by the Chemical Department of the Experiment Station prior to 1895 were published in Bulletin 15, in which the results were summarized as follows:

“Sugar beet seed was distributed last spring to 1,015 farmers, representing every county in the state except Okanogan.”

“Sample beets for analysis were received from 384 different parties, representing 27 counties.”

“Seventeen hundred (1,700) samples were analyzed, coming from 101 different towns — 45 being west of the Cascade mountains and 56 in Eastern Washington.”

“The general state average of 1,666 analyses was as follows: Weight, 25 oz.; sugar, 14.2 per cent.; purity, 82.6.”

“The elimination of 122 analyses of a variety wholly unadapted to our state gives for 1,544 analyses the following averages: *Weight*, 22 oz.; *sugar*, 15.2 per cent.; *purity*, 83.8.”

“These results demonstrate that Washington can produce sugar beets of a very superior quality.”

These results were so gratifying and seemed to promise so much for the future of the state, that a continuance of the experimentation along definite and specific lines was deemed desirable. The sugar content and purity exhibited by beets from an area of a few hundred square feet, only indicated that equal success *might* follow their cultivation on a larger scale. The proof of this point was lacking. Hence it was highly important that work should be undertaken which would show the character of beets grown on acre tracts, and also furnish some figures relative to the yield per acre and cost of production. It was also desirable that these points should be determined with reference to the state as a whole — at the same time taking meteorological observations, in order that the climatic conditions under which the crops were grown would be

positively known. To carry out the work, as above mentioned, it would be necessary to establish beet stations in various parts of the state, which would involve an expenditure of more money than was at the disposal of the station for this purpose. To meet this emergency, the legislature of 1895, recognizing the importance of the work proposed, passed House bill No. 511—a bill appropriating \$1,500 for further sugar beet experimentation. The detailed results of the work made possible by this appropriation are embodied in this bulletin.

The plan adopted by the station was to obtain the use of an acre of land, rent free, for the experiment—the station to furnish the seed and make the analyses, the donor of the land to furnish the labor and to have the crop. The station was also to furnish to each one undertaking the work a maximum and minimum self-registering thermometer, a soil thermometer, and rain gauge. In each case those furnishing the labor agreed to keep an accurate account of the amount and value of the labor performed and also to keep a correct record of the meteorological observations. It is a source of much regret that for various reasons the records, both of labor and weather, were in some cases either neglected or imperfectly reported, thus seriously impairing the value of the experimental work. In performing coöperative work of this character, where the work is voluntary and does not carry direct remuneration, it is always difficult to secure the best possible results. This is due neither to disinclination nor lack of good faith on the part of the coöperators. Usually the explanation is found in the advent of unforeseen circumstances in the surroundings and conditions which interfere with the plans outlined by the individual farmers. Sometimes, however, imperfect coöperation is due to a lack of appreciation of the prime importance of accuracy and fidelity in scientific experiments. Perhaps due to a combination of the above causes, the work of 1895 was not as satisfactory as could have been desired. However, we are grateful to all who participated in the work and believe the data obtained to be of great value, even though somewhat incomplete. We found difficulty in some sections to find any one willing to work with the station in the manner above noted. After a long and tedious correspondence we finally selected fourteen places for the acre tracts—the choice being governed largely by the character of the beets raised in 1894 at these places. The towns chosen were as follows: Hartford, Snohomish

county; Yakima, Yakima county; Crescent, Lincoln county; Farmington, Colfax and Pullman, Whitman county; Waverly, Spokane county; Chehalis, Lewis county; Vancouver, Clarke county; Orting, Pierce county; Nooksachk, Whatcom county; Dayton, Columbia county; Ellensburg, Kittitas county; Puyallup, Pierce county. The men whose coöperation was secured were as follows: Hartford, T. J. Patterson; Yakima, W. T. Clark; Crescent, Otto Wollweber; Farmington, F. A. English; Colfax, I. B. Harris; Pullman, E. B. Monlux; Waverly, John R. Reavis; Chehalis, J. C. Bush; Vancouver, C. M. Dietrich; Orting, Henry Beckett; Nooksachk, J. Swinehart and J. W. Sefton; Dayton, Leroy Brown; Ellensburg, B. P. Shifflette; Puyallup, Supt. F. A. Huntley.

Some delay was experienced in getting the work under headway for the season of 1895, owing to the fact that the appropriation did not become available until ninety days after the approval of the bill. We were able, however, to furnish the seed in time for early spring planting, although the meteorological instruments were not furnished to the different stations until August. Unfortunately, the spring of 1895 was exceedingly wet and cold, and in every way unfavorable to seed germination. These unusual climatic conditions, coupled with a disastrous visitation of the flea beetle just as the beet plants were coming up, brought about a total failure of the plantings at Farmington, Colfax and Pullman. The acre at Yakima was also reported a failure, due, largely, to the ravages of squirrels and rabbits. While these failures are somewhat discouraging, they are not to be considered as serious unfavorable indications. The insect ravages would have been of little consequence had the weather been such that seeds could have germinated earlier, for the pests did not appear until the time when the beet plant is usually able to resist their attacks. There is no beet growing country in the world that is not subject to occasional adverse climatic conditions. As will be shown later, our climate will compare more than favorably with that which prevails in many portions of beet growing Europe.

The area of land actually devoted to these experiments was—one acre at Crescent, Waverly, Chehalis, Vancouver, Orting, Nooksachk, Dayton, Yakima, Farmington, Colfax and Pullman; one-half acre at Puyallup and Ellensburg, and one-eighth acre at Hartford.

When the beets were matured, instructions were given to harvest about fifty samples from each field, selecting them in such a way

that they would represent a fair average of the beets growing in the entire field. Each one of these was analyzed separately, in order to ascertain if they possessed a uniform character. We give below the averages of these analyses for each locality.

Locality.	Date of analysis.	No. samples	Average weight, ounces.....	Average sugar in beet.....	Average sugar in juice	Average purity...	POOREST SAMPLE.			BEST SAMPLE.		
							Sugar in beet	Sugar in juice.....	Purity	Sugar in beet	Sugar in juice.....	Purity
Puyallup	Oct. 21	50	17	17.1	18.0	89.1	13.5	14.2	87.0	19.2	20.2	94.0
Chehalis	Nov. 1	50	23 ³ / ₄	16.4	17.2	85.1	11.1	11.7	75.0	19.0	20.0	93.0
Ellensburg....	Nov. 2	52	14	17.1	18.0	88.2	14.7	15.5	81.1	19.0	20.0	90.1
Hartford	Nov. 6	50	12	17.0	17.9	88.8	14.6	15.4	81.9	20.0	21.1	89.1
Nooksachk. .	Nov. 21	50	19	15.6	16.4	89.1	11.9	12.5	80.1	18.0	19.0	93.1
Dayton	Nov. 29	50	11	13.6	14.3	81.3	8.1	8.5	73.5	17.4	18.3	90.5
Vancouver...	Nov. 30	51	34	14.2	15.0	87.2	10.0	10.5	75.6	17.8	18.7	90.7
Orting	Dec. 3	56	18	16.8	17.7	92.7	12.9	13.6	82.4	20.9	22.0	89.4
Waverly	Dec. 5	55	17	18.5	19.5	89.4	12.1	12.7	78.9	22.4	23.6	92.9
Crescent.....	Dec. 7	57	8	15.8	16.6	87.8	10.0	10.5	80.2	19.2	20.2	90.2

The seed furnished by the station was the variety "Klein Wanzlebener," imported through the Beet Sugar Company at Watsonville, California.

The above figures are worthy of careful consideration. It should be emphasized that they do not represent single analyses, but are the averages of typical beets taken from acre tracts, and can justly be said to show the character of the entire acre. As far as individual analyses are concerned, we believe there is no well authenticated analyses on record showing a higher percentage of sugar and purity, than the best sample received from Waverly. In all cases the analyses were made within one week of the date of harvesting, hence it is noteworthy that the superior character of the beets is maintained until as late as December 1st, after having been exposed to the fall rains. This is a point of *very great* importance, and will be more fully discussed in the subsequent pages.

CHARACTER OF SOIL.

Several different types of soil were represented in these experiments, varying from a light sandy soil to the dark, heavy clay loam of the Palouse country. At Puyallup the type was the alder bottom land so common in Western Washington. It is a soil generally rich in organic matter and phosphoric acid, but deficient in lime and potash. At Chehalis the acre was divided into two equal tracts, one of which was a light, sandy loam with good natural

drainage; the other was "dark, heavy prairie ground" which, although different in some respects, may be classed with the alder bottom land. At Ellensburg, near the foothills of the Cascades on the eastern side, and at Orting, near the foothills on the western side, the soil possessed a strong sandy character, that at Orting being of a finer texture, and containing more organic matter, but much less lime and potash than that at Ellensburg. The type at Hartford was the red fir upland, containing, however, more sand than is common to the type in general. Like the alder bottom land, the fir upland is usually deficient in lime and potash. The soil at Nooksachk was very peculiar, and cannot be classified as one of the Washington types. It was land that had been ditch drained for some time, its chief characteristic being the very large amount of unhumified organic matter it contains. It is very deep, light and porous. The plat selected at Dayton was an unfortunate one, and accounts in a large measure for the inferior quality of the beets raised on it. It must be remembered, however, that this is only a *relative* and not absolute inferiority. The beets were grown upon a high and exposed side hill, where the drying power of the sun and winds prevented normal growth. The soil was a clay loam. At Vancouver the beets were raised upon the first bench above the Columbia river. Although the saccharine matter in them was lower than in those raised at other places (Dayton excepted), yet when we consider their average weight of 34 ounces, their value per acre would be even more than those from Waverly containing 19.5 per cent. of sugar, and having an average weight of 17 ounces. The soil at Waverly can neither be called a sandy loam, nor yet a clay loam—it is about midway between. It seems to be the transition point between the clay loam of the Palouse country and gravelly soil of Spokane county. It is an excellent soil for beets. The soil at Crescent is quite similar to that at Waverly, but contains less organic matter and less fine sand. It could well be called a light clay loam.

In connection with these facts, concerning the soil, it is well to consider the general characteristics of Washington soils in their relation to sugar beet culture. It is conceded by the best authorities that a certain type of soil, viz., a light sandy loam, is best adapted to the habits of the sugar beet. But this type is found in only limited areas in the state, and generally in regions where crops cannot be grown without irrigation. The types of soil upon

which beets have been grown in this state, are the heavy clay loam of the Palouse country, the light sandy soil of the Kittitas and Yakima valleys and the upland and bottom land of Western Washington, the latter often containing a large amount of organic matter. Thus the so-called "standard" beet soil is not standard for this state. A light sandy loam is recommended for beets (1) because it usually has considerable depth; (2) because it is easily penetrated by roots; (3) because it does not retain excessive moisture; (4) because it permits a comparatively free circulation of air to the roots. Are not these conditions fulfilled in Washington soils? Those of Eastern Washington are undoubtedly of volcanic origin. The hills and hollows of the Palouse country owe their characteristic configuration to the agency of winds, and hence, as would be naturally expected, their soil is in an exceedingly fine state of division, and in most localities also very deep. This fineness and depth make it an easy matter for the beet root to follow its natural inclinations in the matter of downward growth and development. There is rarely an excess of water in the soil during the growing season because of the scant rainfall during that period. All root crops make a phenomenal growth here, thus testifying that the supply of air so essential to crops growing underground, is ample.

In Western Washington, the soils are in the main the results of glacial action and sedimentation. Hence they are not so finely divided as the wind soils. By the gradual accumulation of decayed leaves and vegetation, they have been largely modified in their physical conditions, the large amount of unhumified organic matter making them light and porous. This accumulation has also naturally led to an increase in depth which, together with the porosity, gives to the growing roots freedom of development, and permits free circulation of air. Thus it is that the heavy clay loam of the Palouse country, the drift soils of Western Washington, the loess soils of Nebraska, and the lighter soils of California are essentially the same in their relation to the production of root crops. For the comparison of chemical composition we give the following analytical table including soils from Eastern and Western Washington, the beet districts of Nebraska and California, of France and Russia:

	Whitman county.	Spokane county, average of 5 analyses.	Norfolk, Nebraska.	Whatcom county, average of 6 analyses.	Yakima county, average of 5 analyses.	* Chino, Califor- nia.	Fremont, Nebraska.	† France.	King county, average of 2 analyses.	‡ Russia.
Insoluble silica.....	62.8314	67.5044	57.1863	64.4965	73.5939	62.62	67.5283	81.8000	77.7844	72.6990
Combined silica.....	13.6630	8.0786	16.0350	6.6728	8.0745	8.30	11.9390		5.0542	
Soluble silica.....	0.3010	0.1418	0.0707	0.0760	0.4003	0.95	0.1732		0.1127	
Potash (K ₂ O).....	0.6351	0.5348	0.8104	0.2368	0.2301	0.50	0.7867	0.0640	0.0304	2.0470
Soda (Na ₂ O).....	0.3739	0.1719	0.1591	0.7433	0.5992	5.07	0.1432	0.0850	0.3561	0.9140
Lime (CaO).....	1.0814	0.6923	0.5673	0.8632	1.4360	0.84	0.4355	0.5100	0.4940	1.9300
Magnesia (MgO).....	0.7277	0.1977	0.7682	0.2128	0.1913	0.06	0.2585		0.3887	
Ferric oxid (Fe ₂ O ₃).....	4.5539	3.8161	3.7427	6.8556	5.5041	6.43	1.3009	2.8800	3.1047	2.8340
Alumina (Al ₂ O ₃).....	7.5263	7.7156	8.0356	8.4740	6.1005	4.88	7.9041	7.2400	4.6711	9.9740
Phosphoric acid (P ₂ O ₅).....	0.1423	0.1362	0.1199	0.1607	0.1250	0.21	0.1008	0.0700	0.0639	0.0930
Sulfuric acid (SO ₃).....	Trace.	0.1651	0.1287	0.0192	0.1981	0.06	0.0378		0.0278	
Chlorin.....	0.0204	0.0096	0.0079	0.0102	0.0046		0.0181		0.0145	
Water at 120° C.....	4.5234	2.3799	4.2481	4.3878	1.5176	6.02	3.0800		1.5733	
Volatile and organic matter.....	3.6124	8.2813	7.7425	7.3983	2.4105		6.4805	5.6000	6.1016	6.2070
Total.....	99.9922	99.8253	99.6224	100.4072	100.3887		100.1866		99.7774	

* Rep. Cal. Sta., 1890.

† "Sugar Beet," pp. 103-4.

‡ "La Bettrave a Sucre," p. 82.

Sugar beets draw quite heavily upon the soil for potash and phosphoric acid. An inspection of this table shows that Washington soils are richer in phosphoric acid than any of the others, but contain less potash than those in Nebraska, California and France. The potash percentage in the Russian soil is abnormal. Washington soils are capable then of producing good crops of beets because of chemical composition as well as physical conditions.

As before stated, the meteorological data received from some of the beet growers, is very incomplete. The object in view—that of determining the exact climatic conditions under which the experimental beets were grown—was defeated by our inability to furnish the instruments until very late in the season. However, the data received is valuable, meager as it is, particularly as showing the kind of weather prevailing during the harvesting season. We give it below as fully as possible.

CRESCENT.

Date.	TEMPERATURE OF AIR.		Mean soil temperature	Precipitation in inches	TEMPERATURE OF AIR		TEMPERATURE OF SOIL.	
	Mean maximum.....	Mean minimum.....			Maximum....	Minimum.....	Maximum....	Minimum.....
1895.								
July	86.4	49.0	77.2	0.58	95	42	82	70
August.....	87.2	44.7	71.5	0.00	98	36	79	62
September.....	65.1	37.4	56.3	1.82	90	25	72	50
October	66.6	31.3	52.4	1.62	77	18	61	39
November	42.1	24.9	.....	1.94	54	7	.....	.....
December.....	35.3	21.4	.....	1.86	48	-3	.....	.....
1896.								
January	36.0	21.3	.....	1.54	46	2	.....	.....
February.....	43.8	28.4	.....	0.55	54	13	.....	.....
March	48.3	25.0	38.8	1.36	64	1	49	31
April	55.7	30.7	42.4	2.13	70	19	50	31
May	64.2	37.5	48.0	3.88	85	31	68	41
June	78.8	45.4	65.5	0.39	98	34	80	52

It is worthy of note that the beets raised at Crescent yielded 16.6 per cent. sugar, and a purity of 87.8. They were not harvested until about December 1. During July and August they received but 0.58 inches of rain. During September, October and November the rainfall amounted to 5.38 inches. There was no evidence of second growth after exposure to this rain, probably because the very cool nights and comparatively low mean maximum temperature were unfavorable to such growth. The severe freezing weather indicated by the minimum temperature of 7°, which occurred on

the 22d of November, lasting for four days, and which was followed by thawing weather from the 26th to 30th, appears to have had no deleterious effect upon the character of the beets.

CHEHALIS.

Date.	TEMPERATURE OF AIR.		Mean soil temperature.....	Precipitation in inches.....	TEMPERATURE OF AIR.		TEMPERATURE OF SOIL.	
	Mean maximum.....	Mean minimum.....			Maximum.....	Minimum.....	Maximum.....	Minimum.....
1895.								
October.....			46.8	0.17			55	40
November.....	50.2		38.0	5.33	65		52	34
December.....	44.8			12.09	58			
1896.								
January.....	46.0		36.6	8.22	55		46	28
February.....	50.5		38.7	5.32	62		50	32
April.....	55.8		42.5	5.20	71		52	38
May.....	62.8		47.4	3.80	85		62	42
June.....	73.6		58.0	1.25	99		70	48
July.....	84.2		66.7	0.20	97		75	62

PUYALLUP.

1895.								
September.....	64.8	41.3	56.3		74	27	59	52
October.....	58.3	38.4	53.1		70	27	60	48
November.....	47.9	34.7		4.88	61	19		
December.....	43.7	34.0		11.51	58	21		
1896.								
January.....	46.0	33.1		6.11	60	16		

The beets grown at Chehalis were harvested October 22, and hence had not been exposed to the fall rains. The same is true of those raised at Puyallup, which were harvested about October 15. In both cases the tops were still fresh and green, giving evidence of a lack of maturity. It is probable that had these beets remained in the ground a month longer, protected from rains, that the sugar content would have been somewhat higher. The Chehalis beets were much larger than those grown at Puyallup. This is explained by the fact that the rows were 30 inches apart at Chehalis instead of 18 inches as at Puyallup. We wish here to state again that our experiments show conclusively that the *size* of the beets has less influence on sugar content and purity in case of Washington beets than those grown elsewhere in the United States. We are unable at present to give an explanation of this, beyond the evident fact that for some reason the energy of the large beets is expended more in the formation of sugar than the production of woody fiber.

VANCOUVER.

Date.	TEMPERATURE OF AIR.		Mean soil temperature.....	Precipitation in inches.....	TEMPERATURE OF AIR.		TEMPERATURE OF SOIL.	
	Mean maximum.....	Mean minimum.....			Maximum....	Minimum.....	Maximum....	Minimum.....
1895.								
November.....	51.2	37.0	42.6	.....	64	23	51	35
December.....	45.6	36.4	38.0	.....	60	28	47	34
1896.								
January.....	47.3	34.8	38.3	.....	58	20	45	33
February.....	52.8	37.7	42.0	.....	66	26	47	36
March.....	55.3	34.4	44.2	.....	67	19	51	33
April.....	56.1	38.6	48.3	.....	68	26	54	44
May.....	62.4	43.5	51.6	.....	84	37	61	46
June.....	72.1	47.9	63.3	.....	93	39	75	53
July.....	82.5	52.7	74.6	.....	96	47	83	65
August.....	75.8	53.3	71.4	.....	93	47	81	63

Unfortunately, the record of rainfall, together with all data concerning cost of production and details of work, were lost by high water. Hence, the experiments at Vancouver can almost be called a failure. On a subsequent page some data will be found concerning the experimental work at this point for the year 1896.

NOOKSACKH.

Date.	TEMPERATURE OF AIR.		Mean soil temperature.....	Precipitation in inches.....	TEMPERATURE OF AIR.		TEMPERATURE OF SOIL.	
	Mean maximum.....	Mean minimum.....			Maximum....	Minimum.....	Maximum....	Minimum.....
1895.								
August.....	81.6	72.4	55.2	0.41	92	72	64	44
September.....	63.1	56.1	41.7	5.55	80	51	45	38
October.....	60.0	49.3	39.5	0.57	78	30	46	30

HARTFORD.

1895.								
September.....	70.7	39.5	47.2	2.26	78	28	50	40
October.....	66.7	35.1	41.7	0.64	75	29	50	38

Nooksackh beets showed 16.4 per cent. sugar, purity 89.1, and those from Hartford 17.9 per cent. sugar, purity 88.8. The former were harvested November 15, after having received $5\frac{1}{2}$ inches of rain in September, which was followed by a warm October. The latter were harvested November 1.

PULLMAN.

<i>Date.</i>	TEMPERATURE OF AIR.		<i>Precipitation in inches.....</i>	TEMPERATURE OF AIR.	
	<i>Mean max- imum.....</i>	<i>Mean min- imum.....</i>		<i>Maximum....</i>	<i>Minimum.....</i>
1893.					
February.....			1.75		
March.....			1.75		
April.....			3.13	61	
May.....	57.9	40.4	1.74	79	33
June.....	66.4	44.2	0.67	79	37
July.....	78.1	47.4	1.05	98	37
August.....	82.0	48.3	0.00	95	38
September.....	68.3	45.3	2.32	93	33
October.....	50.8	36.6	4.64	64	26
November.....	40.6	30.0	3.53	55	19
December.....	39.6	31.1	1.54	48	17
1894.					
January.....	30.8	21.7	3.33	44	20
February.....	31.0	19.3	0.85	40	—10
March.....	42.1	29.5	3.17	58	18
April.....	53.5	36.5	1.23	73	26
May.....	63.5	43.5	1.82	85	30
June.....	67.6	47.4	0.89	84	32
July.....	81.2	57.1	0.44	94	41
August.....	85.4	51.4	0.10	98	42
October.....	51.8	38.3	2.84	77	31
November.....	48.2	35.2	2.05	61	20
December.....	34.2	25.2	0.69	43	11
1895.					
January.....	32.1	22.1	1.16	44	4
February.....	41.2	27.4	1.07	55	19
March.....	46.2	29.2	0.57	62	11
April.....	60.2	36.0	0.83	76	25
May.....	62.7	40.1	2.12	82	31
June.....	71.2	45.4	0.19	90	36
November.....	42.2	29.3	2.24	58	12
December.....	35.2	24.3	0.92	49	4
1896.					
January.....	37.3	26.3	2.75	51	5
February.....	42.2	31.5	1.65	59	17
March.....	44.2	27.3	1.73	66	3
April.....	51.2	34.4	1.89	62	22
May.....	57.0	38.4	2.42	84	30
June.....	75.5	46.2	1.60	94	38
July.....	86.1	55.7	0.15	98	44
August.....	82.1	50.3	1.21	95	38
September.....	69.2	43.4	0.43	85	30
October.....	60.1	48.2	0.90	77	25
November.....	35.9	24.1	6.81	60	—12

The meteorological data above given for Pullman, are taken from the records of the voluntary weather observer for this point. These figures would be approximately correct for the greater portion of Whitman county. Although the records are incomplete for the calendar year 1895, the total precipitation was only a little more than half as much as for the year 1896. The latter year, up to December 1, had 21.54 inches precipitation. The amount for 1894, viz., 17.4 inches, is about normal for this county.

COMPARISON OF RAINFALL AT CHINO, CALIFORNIA, FARMINGTON AND PULLMAN, WASHINGTON.

Date.	Chino.....	Farmington..	Pullman.....	Date.	Chino.....	Farmington..	Pullman.....	Date.	Chino.....	Farmington..	Pullman.....
1893.	In.	In.	In.	1894.	In.	In.	In.	1895.	In.	In.	In.
Sept.....			2.32	Nov.....			2.05	Oct.....	0.08	0.25	.....
Oct.....	1.47		4.64	Dec.....	8.25		0.69	Nov.....	0.66	2.48	2.24
Nov.....	0.61		3.53	1895.				Dec.....	0.66	1.40	0.92
Dec.....	3.92		1.54	Jan.....	9.02		1.16	1896.			
1894.				Feb.....	1.01		1.07	Jan.....	2.24	2.88	2.75
Jan.....	1.10		3.33	March.....	3.87		0.57	Feb.....		1.60	1.65
Feb.....	0.51		0.85	April.....	0.31		0.83	March.....	4.22	1.14	1.73
March.....	0.47		3.17	May.....	0.30	1.72	2.12	April.....		1.90	1.89
April.....	0.25		1.23	June.....		0.31	0.19	May.....		2.20	2.42
May.....	0.21		1.82	July.....			0.52	June.....		0.82	1.60
Sept.....	0.24			Aug.....				July.....		0.33	0.15
Oct.....			2.84	Sept.....		2.30		Aug.....		0.10	1.21

The above table is given for comparison. It is of more interest than inherent value, because the temperature conditions as well as rainfall at Chino are very different from those which prevail here. Chino has also an ideal harvesting season, because of the minimum precipitation which occurs from June until December.

In considering the relations of annual precipitation to sugar beet production, its distribution during the growing and harvesting seasons is perhaps fully as important as the aggregate amount for the year. Any great amount of precipitation during the harvesting season is prejudicial, not only because of the increased labor connected with harvesting and delivering the beets, but also because of the tendency of the rain to induce a second growth in the beets, which always lowers the sugar content and purity to a greater or less extent. Hence it is desirable that the months of September, October and November particularly should be comparatively free from rain, especially when accompanied by warm weather.

Because the beet growing countries have a certain amount of rainfall it has been generally conceded that the successful culture of sugar beets depends upon a certain maximum and minimum amount. It is supposed that anything below the minimum amount, while it may produce beets rich in sugar, will reduce the tonnage yield below the limit of profitable production; while an amount of precipitation greater than the maximum will produce a large tonnage yield, but will reduce the percentage of sugar in the juice below the limit of profitable manufacture. It is a singular

and noteworthy fact that the amount of rainfall throughout the Palouse country is below the minimum, while that west of the mountains is in most places above the maximum, and that in both of these sections beets of an excellent quality are produced, which give a satisfactory tonnage yield.

In those portions of Eastern Washington outside of the irrigation districts, the average annual precipitation does not exceed 18 inches. During the calendar year 1895, the total in Whitman county was slightly less than 12 inches, and yet drouth conditions did not prevail. The effect of the low rainfall was more marked upon garden produce and root crops than upon wheat and other cereals. The normal amount of rainfall, *i. e.*, 18 inches, furnishes sufficient moisture for the full development of crops in general in Eastern Washington, while in the eastern and middle states the same amount would involve conditions of extreme drouth. This contrast can be rationally explained by the difference in the texture and general physical properties of the soil, and the relation of the surface water to the underlying water table. In the humid regions of the east the average annual rainfall is, approximately, 40 inches. There the soil is of such a character that the water received upon its surface percolates through it with little difficulty until it reaches the underground water. The character of the soil, and the proximity of the water table to the surface, are conditions which produce a moist subsoil; and wherever this exists the percolation above mentioned is quite rapid. In these humid regions it is estimated that at least one-half of the total rainfall is lost for plant use by running off the surface in streams and by its downward movement through the subsoil. Hence, the available moisture is only a little greater than the total precipitation in Eastern Washington. Here there seems to be no connection whatever between the surface water and an underlying water table. At a comparatively short distance below the surface a dry substratum of soil is invariably encountered which is almost impervious to water because of its finely divided state, and because of its distance from underground water. This dry substratum practically prevents any of the moisture received upon the surface from being lost by percolation. All of it is retained within easy reach of the plant roots. The loss by evaporation is also less than with soils of a coarser texture. The 18 inches precipitation for Eastern Washington includes both rain and snow fall. Just how much of this is available for vegetation

is as yet an unsolved problem. It is certain, however, that the soil receives but little moisture from snow which is removed by Chinook winds. It is probable that in an average season not more than 12 inches are directly available for crops, this estimate being based on the assumption that little or no water is lost by downward percolation, or by running off the surface. It should also be remembered that although evaporation in general is much more rapid here than in the humid regions, the loss of soil moisture by evaporation may be no greater — perhaps even less — due to the greater power of our finely divided soil to retain it. Thus may be explained, in part at least, why the quality and yield of sugar beets grown under this small precipitation equals or exceeds that of beets grown under the “standard” conditions of rainfall. It is very noticeable that in both Eastern and Western Washington, the monthly rainfall for June, July and August is far below the minimum amount considered necessary for these months by Dr. McMurtrie.

REPORTS FROM ACRE TRACTS.

Concerning the acre tract at Chehalis we quote the following statements of J. C. Bush:

“Two pieces of ground containing each one-half acre were selected. The first was a sandy soil and the second a dark, heavy prairie ground. The ground was plowed very deep when in good condition, thoroughly harrowed, and the clods pulverized to fine dirt. April 26 the sandy half-acre was planted, a common garden drill being used, and the rows planted thirty inches apart which was supposed to be as close as they could be cultivated with a horse. April 30 the prairie half acre was planted. The ground was worked twice with a horse cultivator; the beets were hoed and thinned during May and June, and were given a “laying by” hoeing July 10. There were some sand fleas on the sandy patch and for a while they seemed to be injuring it, but the beets began to grow vigorously about the middle of June, and nothing bothered them after that. The season was very dry, the rainfall for June being 0.59, July 0.27, and for August only 0.02 inches. The dry weather was noticeable on the prairie field, but did not seem to affect the other patch. The beets were harvested October 22. The tops were cut off, the beets thrown into wagons and hauled to the scales. The yield was: Sandy patch, 14,294 pounds; prairie patch, 10,190 pounds; total, 24,464 pounds. If the rows had been eighteen inches apart (as they are when sugar beet raising is a business) instead of thirty inches, the yield at the same rate would have been 40,929 pounds. A total of thirty-two day's time for one man, and ten day's time for a horse, were spent on the patches. This was more than was really necessary, as it was found by experience that some things could have been

done at a considerable saving of time if the experimenter had only known how. The chemical analysis showed that the percentage of sugar was almost exactly the same in the twenty-six samples from the sandy patch, and the twenty-six grown on prairie soil, but the purity of the former was nearly 4 per cent. higher. The fifty-two samples analyzed were taken from every row and from every part of both patches, and included big, little, and medium beets. They were as fair a representation of the whole lot as it was possible to obtain."

It will be seen from the above data that 175 days intervened between the dates of planting and harvesting. Mr. Bush estimates the value of the labor employed at \$37, but states that in beet raising as a business, using proper machinery and methods, this cost would be very much lessened. Allowing \$10 for rent of ground, \$2 for seed, and \$37 for labor, the net profit from the 20 tons of beets, if sold to a factory at \$4 per ton, would be \$31, less the cost of delivery.

At Nooksack, one-half acre was raised by J. Swinehart, and one-half acre by J. W. Sefton. Mr. Swinehart furnishes the following data as to cost of production of his half acre:

Plowing, $\frac{1}{2}$ day.....	\$1 50
Harrowing and rolling, $\frac{1}{2}$ day.....	1 50
Raking, 1 day.....	1 50
Planting, $\frac{3}{4}$ day.....	1 00
Thinning, 3 days.....	4 50
Weeding, $2\frac{1}{2}$ days.....	3 75
Total.....	\$13 75

It will be noted that this estimate of \$27.50 per acre does not include the cost of harvesting.

Mr. Sefton reports the yield of his half-acre as 21,300 pounds, or a little over 21 tons per acre.

The estimated cost of production on the one-eighth acre at Hartford was at the rate of \$25 per acre, and the yield reported as from 14 to 15 tons per acre.

The yield at Puyallup as determined by actual weight was at the rate of 45,240 pounds, or nearly 23 tons per acre.

No definite data concerning yield or cost of production were furnished from Vancouver, Dayton, or Waverly. However, at Dayton the yield per acre was low for reasons already given, while at Vancouver and Waverly the tonnage was high.

Mr. Otto Wollweber makes the following statements concerning the acre raised by him at Crescent: "The plat was plowed an

average of 8 inches deep in the fall. I estimate the cost of production as follows:

Plowing eight inches deep.....	\$1 50
Harrowing to break crust, clod mashing and cutting up with disc harrow, one-half day.....	75
Harrowing and smoothing, one-fourth day.....	40
Plowing ten inches deep, disc harrowing and rolling, one day.....	2 00
Seeding with hand seeder, one day	1 00
Hoeing by hand, two days.....	2 00
Thinning, eight days.....	8 00
Cultivating by hand, three and one-half days.....	3 50
Harvesting, three days.....	3 00
Total	\$22 15

This record of cost of production may be relied upon. Mr. Wollweber has had wide experience in raising sugar beets, and is highly competent to make an accurate estimate. Concerning yield Mr. W. says: "The yield was only about 5 tons of marketable beets." We saw this acre early in July, at which time it promised to yield 20 tons. The drouth became very severe in the latter part of July, and this, together with very hot, dry winds, caused the partial failure.

Concerning the acre at Farmington which was a total failure, Mr. English writes as follows:

"Our climatic conditions during this spring were very unfavorable to the growth of plants. The season although opening rather early is in spite of it farther behind than any other year. Dry weather, winds, and wet, cold weather were the cause. The growth was too slow, and that is the reason the ravages of insects were so killing. I have raised lots of beets every year during the past four years, but never have had such miserable luck with them."

Mr. F. E. Deeringhoff, of Uniontown, Whitman county, also raised two acres of beets, and gives cost and yield in detail. These statements should carry much weight, for Mr. Deeringhoff has also had large experience in beet growing in Germany. He says:

"The figures given in the following estimate are very high, and would be nearly one-half less by the use of proper machinery. The laborers were inexperienced, and the cultivation was not proper. The ground was not subsoiled. After seeding a heavy rain fell and washed the seed away from the side hill land. One-fourth of the two acres was side hill, and there the stand was too thin, the beets being overgrown. On the level, where the beets stood 12 to 18 inches apart, they had the proper shape and weight. On account of the ground not being subsoiled, the beets grew above the ground, which caused an inferior quality. I am sure that where the soil is plowed deep, and subsoiled, the yield would

be much larger, and the percentage of sugar higher. When proper cultivation is given, I estimate that our soil could produce 30 tons per acre."

Seed.....	\$5 60
Express on seed.....	4 00
Seeding.....	2 00
First cultivation	3 50
Thinning.....	5 00
Second cultivation.....	2 50
Third "	2 50
Harvesting and putting in silo.....	19 00
Extra hand labor on weedy spots	4 00
Rent of land	10 00
Total.....	\$58 10

Estimated yield, 40-45 tons.

This estimate makes the cost of production \$29.05 per acre. Under date of December 8, 1895, Mr. D. writes:

"There was no second growth this year, and if the beets are cultivated properly there is no danger of it at all. Beets can be raised here to the very best advantage."

EXPERIMENTS IN 1896.

Experiments having been made in 1895 in the production of home-grown seed, it was determined to use the Washington seed for the work of 1896. Hence a sufficient amount of it was procured from Mr. F. E. Deeringhoff, of Uniontown. Having predicted two years before that sugar beet seed grown under our climatic and other local conditions would yield fully as satisfactory results as the imported seed, we watched with great interest the outcome of these experiments. The following figures show, we think, that our predictions are at least partly verified. The seed used was of the variety "Vilmorin blanche." It produces beets having a pink skin, very white pulp and rosette shaped tops. The leaves cling closely to the ground. Some questions having arisen concerning the probability of the occurrence of second growth and its effect upon the saccharine matter, we determined to confine the work chiefly to a consideration of these points. For this purpose beets were raised at the Ross station at Puyallup, at Crescent, Lincoln county, and on the college farm at Pullman. In order to ascertain the rate of increase or decrease of the saccharine matter (due to second growth) samples were taken in a uniform manner and at stated intervals for analysis. We give below the results obtained from the samples sent from Puyallup. [See next page.]

<i>Date of harvesting.</i>	<i>Date of analysis.</i>	<i>No. of beets.....</i>	<i>Average net weight in ounces.....</i>	<i>Average per cent. sugar in juice.....</i>	<i>Average per cent. sugar in beet.....</i>	<i>Average purity.....</i>	<i>Remarks.</i>
Aug. 14.....	Aug. 19.....	80	0.7	7.8	7.4	69.0	—
Aug. 24.....	Aug. 27.....	49	2.1	10.8	10.3	78.3	—
Sept. 3.....	Sept. 8.....	61	2.7	11.0	10.4	86.9	—
Sept. 13.....	Sept. 22.....	54	3.9	12.3	11.7	81.2	Poorly shaped beets.
Sept. 23.....	Sept. 28.....	60	4.6	11.8	11.2	76.1	
Oct. 3.....	Oct. 7.....	62	4.4	12.6	11.9	78.8	
Oct. 13.....	Oct. 17.....	73	5.3	13.9	13.2	84.7	
Oct. 23.....	Oct. 31.....	8	12.5	13.9	13.2	80.8	Large.
".....	".....	33	7.3	13.5	12.8	79.9	Medium.
".....	".....	29	3.5	14.2	13.5	82.5	Small.
	Average..	70	6.3	13.8	13.1	81.1	
Nov. 2.....	Nov. 6.....	7	13.1	12.5	11.8	77.5	Large.
".....	".....	23	7.0	13.3	12.6	80.1	Medium.
".....	".....	25	3.4	14.1	13.4	77.0	Small.
	Average..	55	6.1	13.6	12.9	78.4	
Nov. 12.....	Nov. 17.....	7	13.1	14.0	13.3	80.0	Large.
".....	".....	18	7.1	13.9	13.2	81.8	Medium.
".....	".....	43	2.8	14.5	13.8	82.8	Small.
	Average..	68	5.0	14.3	13.6	82.3	
Nov. 22.....	Nov. 26.....	5	14.0	14.1	13.4	73.6	Large.*
".....	".....	24	7.1	14.4	13.7	79.6	Medium.*
".....	".....	33	2.6	15.2	14.4	79.6	Small.*
	Average..	62	5.3	14.8	14.1	79.1	
Dec. 3.....	Dec. 11.....	3	13.7	12.0	11.4	74.5	Large.†
".....	".....	37	5.6	12.9	12.3	80.1	Medium.†
".....	".....	34	1.9	13.2	12.5	81.5	Small.†
	Average..	74	4.2	13.0	12.3	80.5	

* Slightly frozen. † Quite badly frozen.

The sugar content and purity of these samples are much lower than last year's crop grown at the same place from imported seed. It is quite possible that seed raised in the Palouse country is not adapted to the climatic conditions of Puget Sound. It is more probable, however, that the low results are due this year to freezing weather which occurred at about the same time the beets reached their best stage last year, thus preventing maturity development. It will be seen from the table that the beets had a maximum sugar content just previous to the severe cold weather. The samples tabulated were taken in a uniform manner, and it is noticeable that the greater number in each lot were very small and undoubtedly immature beets. The effects of the freezing upon the Puyallup beets was more disastrous than upon those grown at Pullman where the temperature was much lower.

The results obtained from the Pullman beets are given below. These samples were taken uniformly but with less regularity than the others. The analyses were made the same day the samples were taken.

<i>Date of analysis.</i>	<i>No. of beets.....</i>	<i>Average net weight in ounces.....</i>	<i>Average per cent. sugar in juice..</i>	<i>Average per cent. sugar in beet...</i>	<i>Average purity...</i>
October 5.....	4	16.5	15.4	14.6	80.2
October 20.....	4	16.2	14.2	13.5	84.0
November 7.....	5	13.4	17.3	16.5	80.9
November 10.....	5	15.0	15.3	14.6	83.2
December 4.....	8	10.9	13.7	13.0	76.5
December 11.....	9	9.1	13.5	12.8	86.5

November 10, rain for three days, then heavy freeze. Temperature November 27 was -12° . December 11, beets in good condition; ground wet and cold.

It must be remembered that these beets were raised from home-grown seed. Owing to very late planting (May 20) they did not reach their maximum saccharine percentage until the first week in November. The truly remarkable character of the figures given cannot be fully realized without taking into account the extraordinary climatic features of the month of November. In order to give a clear idea of the effects of rain, and freezing weather upon the beets, we insert here the weather record from the first of November to the date of writing.

NOVEMBER.

<i>Day.</i>	<i>Maximum temperature..</i>	<i>Minimum temperature..</i>	<i>Rain, in inches</i>	<i>Snow, in inches</i>	<i>Day.</i>	<i>Maximum temperature..</i>	<i>Minimum temperature..</i>	<i>Rain, in inches</i>	<i>Snow, in inches</i>
1.....	46	32			17.....	29	23	0.48	1.00
2.....	43	33	0.33		18.....	32	20		
3.....	45	32			19.....	30	21		
4.....	45	33	0.29		20.....	25	18		
5.....	38	28			21.....	39	26		
6.....	43	30			22.....	36	30	0.46	
7.....	47	28			23.....	35	30		6.00
8.....	45	37	1.31		24.....	22	20		
9.....	41	31	0.32		25.....	16	11		2.00
10.....	41	32	0.18		26.....	12	—2		
11.....	37	28		2.00	27.....	13	—12		
12.....	42	32	0.20		28.....	10	—8		
13.....	50	40	0.30		29.....	18	2		
14.....	57	46	0.59		30.....	24	4		4.00
15.....	60	53	0.33						
16.....	38	33	0.52		Total. ..			6.81	15.00

From December 1 to December 12, the mean maximum temperature was 43.5° ; the mean minimum, 34.4° . The rainfall was 1.56 inches, and the snowfall 6 inches.]

It is thus shown that the samples of beets taken on December 11 had been in the ground during November and had been exposed to 8.37 inches rain, 21 inches snow, and to a temperature of -12° , followed by eleven days of thawing weather. In spite of all these circumstances which generally combine to cause rapid decomposition of the sugar, they show a sugar content of 13.5 per cent., and a purity of 86.5. Many fears have been expressed that the rainfall during the harvesting season would be a serious obstacle to sugar beet culture in this state. We believe these fears to be groundless. Never in the existence of the weather bureau here has there been an autumn of such excessive rainfall and low temperature. Yet, through it all, and in spite of it all, we find beets remaining in the ground even to this date, in good marketable condition, and containing sugar $1\frac{1}{2}$ per cent. above the factory requirements. Mr. Otto Wollweber, of Crescent, who cared for one of the experimental acres in 1895, also raised in 1896 one acre from the Washington seed. One hundred and sixty-eight days intervened between the dates of planting and harvesting. The analytical results given below, obtained from 53 average samples taken from the acre, speak for themselves:

<i>Date of analysis.</i>	<i>No. of beets.....</i>	<i>Average net weight in ounces.....</i>	<i>Average per cent. sugar in juice..</i>	<i>Average per cent. sugar in beet...</i>	<i>Average purity...</i>	<i>Remarks.</i>
October 24.....	9	17.1	18.7	17.7	83.9	Large.
October 24.....	27	12.3	18.0	17.1	80.3	Medium.
October 24.....	17	8.4	19.7	18.7	83.3	Small.
Average	53	11.9	18.7	17.8	81.9	

We also analyzed for Mr. Wollweber three samples of the variety "Vilmorin Richest" which gave the following averages:

Weight, 11.7 ozs.; sugar in juice, 22.5 per cent.; sugar in beet, 21.4 per cent.; purity, 83.5.

Knowing that Mr. Henry J. Biddle of Vancouver, Wash., had been doing some experimental work during the past year, we requested from him a statement of his results. In answer to our request we received from him the following communication:

PORTLAND, OREGON, December 12, 1896.

PROF. ELTON FULMER, *Pullman, Wash.*:

DEAR SIR—I take pleasure in communicating some of the results of my beet analyses during the past season. The beets on my own place,

six miles east of Vancouver, Clarke county, Wash., were analyzed every 10 days with the following results. Each sugar determination is the average of two analyses by the method of hot alcohol extraction, the purity being determined from the specific gravity, and direct polarization of the juice. The samples were taken as follows: Every third beet in 100 feet of row, and every third beet in 100 feet of row three rows distant. All beets were taken in sampling, no matter how small, and the weight taken after washing and topping. The yield is calculated from the total weight of samples, and the proportion the length of row bears to the length of rows in an acre. In *no case* were outside rows, or end beets in a row taken, and I believe the yield as given is fairly correct. The beets were planted May 20th. Seed, Mette's Klein Wanzlebener. The cultivation they received was insufficient and they suffered from the hot weather in July. With deep cultivation the results would have been better.

<i>Date of analysis.</i>	<i>No. of beets.</i>	<i>Average weight in ounces.</i>	<i>Tons per acre.</i>	<i>Per cent. sugar in beet.</i>	<i>Purity.</i>
August 20.....	92	3.4	4.5	13.0	.....
August 30.....	98	4.0	5.5	14.2	.....
September 10.....	92	4.8	7.1	14.4	.....
September 21.....	83	5.8	7.9	14.1	87.1
October 1.....	86	5.9	8.4	14.5	.....
October 12.....	88	6.5	9.5	15.3	89.9
October 22.....	77	6.6	8.3	15.7	90.8
November 1.....	88	6.4	9.3	15.9	85.1
November 11.....	96	6.8	10.7	15.0	87.3
November 20.....	31	6.4	.....	14.8	86.2

The beets were dug November 15, and part stored in shed and part pitted. Analyses were again made December 8.

	<i>No. of beets.</i>	<i>Average weight in ounces.</i>	<i>Tons per acre.</i>	<i>Per cent. sugar in beet.</i>	<i>Purity.</i>
From shed.....	22	8.0	.....	14.0	86.4
From pit.....	24	9.7	.....	13.8	85.5

The latter part of November the temperature fell to 11° Fahrenheit, and beets in the ground were frozen. I am inclined to think that unless severe freezing weather occurs beets will keep as well in this climate when left in the ground as when pitted. In any case a loss of fully 1 per cent. of sugar must be expected.

Beets from fourteen localities in Clarke county gave by alcohol extraction an average of 15.2 per cent. sugar in beet, and 86.0 purity. These were all analyses of large samples taken by myself, and representing fairly well the patches from which they were taken. A number of other analyses were made from samples sent to me. Some of these were irrigated beets, and some quite unripe, and gave on the average poorer re-

sults. The poorest result obtained was 12.25 per cent. sugar in beet with purity 80.2. Average weight 38.8 ounces from irrigated beets.

Yours truly, HENRY J. BIDDLE.

In order to compare our harvesting season with that of other beet-growing sections we quote the following extracts from the weekly Berlin letters published in the Louisiana Planter.

Under date of October 17, 1896:

"The weather with the exception of one or two days has become moist again, but at the same time the temperature is proportionately warm, so that the meteorological conditions are pretty much the opposite of what has been desired; for, instead of improving the quality of the beets, they tend rather to augment the quantity. It can now be considered a settled fact that the saccharine content of the beet is much inferior to last year. Reports to hand from abroad are about of the same tenor—almost everywhere rain and partly also cold weather interrupting the improvement of the crop which would take place on the advent of better weather."

Under date of October 24, 1896:

"The week under review was ushered in by thunderstorms and heavy rains, and also a couple of dry days following this phenomena, which in this country at this time of year is somewhat unusual. The weather on the whole was again predominantly wet and thus perfectly the contrary of what is now desired on the part of the manufacturers, as it prevents the improvement of the quality of the beets. In some places even a lowering of the saccharine contents has been observed, and what is still worse, the harvesting of the beets is sadly hampered, the soil being too wet for man and beast to enter the beet fields, a calamity which in certain sections has caused a temporary interruption of the working of the factory. Besides the beets, if harvested now, are fraught with dirt so that their cleaning is very difficult and expensive, and those now put in silos are exposed to early rotting. You see the early part of the campaign has to deal with many inconveniences which can be mitigated only by the early advent of dry and cool weather. This latter kind of climatic circumstances seems to have existed in Austria, but in France it has been also too wet, and so it was more or less in Belgium and Holland, while Russia reports good harvesting conditions."

Under date of October 31, 1896:

"With the exception of the western part of the empire, where, in consequence of heavy rains, inundations have taken place, the weather has been in the majority of the beet districts dry, and on certain days even sunny, which means a great and favorable change with regard to beet harvesting. The fields have fairly dried up so that almost everywhere, particularly in the central and eastern provinces, work could be resumed and carried on with activity, although the state of the weather is becoming of more importance for the preservation of the beets in the silos. In this respect the temperature is a little too high, and it must be feared

that if no early variation should take place, the beets would soon either rot or develop a new vegetation, the more so as they have been piled up in a moist state—the outcome of which would be a serious loss of quality. In Austria the weather was, in the greater part of the week, dry and cool. France had too much rain, hampering the beet crop in many places. In Holland and Belgium wet weather also interfered with crop work, whilst in Russia they are fairly satisfied on this hand.”

Under date of November 7, 1896:

“The first days and, indeed, the greater part of the week under review, were foggy and rainy, with a mild temperature—all circumstances which, at this period of the season, are utterly disliked by the beet growers as well as by the fabricants; the harvesting being again impeded, the beets are being further exposed to losses in quality. Toward the end of the week, however, there was a sudden change. A night frost set in which has been so intense that another danger loomed up—that of the freezing of the beets still unprotected in consequence of the frequent interruptions of crop work. In France the weather has been more favorable. In Austria it has been about the same as in this country, while Belgium and Holland complained of too much water and all the disadvantages connected with it.”

Under date of November 17, 1896:

“We are now in the season when autumn and winter strive to get the better of one another. This necessarily leads to changeable meteorological conditions, and such we have had throughout the last week; sunny and dark, cool and mild, and wet and dry weather, relieving one another incessantly. But the worst of it was that the mildness and wetness predominated, while at present, for the good keeping of the beets, cool and dry weather is required. The complaints that the beets are delivered at the factory with enormous masses of dirt are almost universal, and deduction as high as 40 per cent. has been made for that reason on the weight of the delivery. At the same time the quality suffers very much, and it is questionable whether the present content of sugar will be preserved. An unfavorable turn has also been taken by the weather in the other beet growing countries of Europe. Rains have set in again in Austria and France, where about the same prospects are prevailing as here.”

From Watsonville (Cal.) Pajaronian, November 26, 1896:

“The prophecies of a wet winter are in a fair way to be fulfilled. On Friday last we had a foretaste in the shape of a shower, and on Saturday night the windows of heaven opened, and it rained until Tuesday afternoon—4.37 inches fell during the storm in the Pajaro valley, and about half that amount in the San Benito and Salinas valleys. Beet hauling is now suspended, but will be resumed at the end of the week if fair weather ensues. There are still about 30,000 tons of beets in the fields of this valley.”

From Chino (Cal.) Champion, October 23, 1896:

"The farmers are exerting themselves to get as many of the fields as possible cleaned up, but 1,500 to 2,000 tons will probably remain out. The crop of this season is less than was anticipated some weeks ago; yet, when the condition of the season is taken into consideration, and the fact that for 18 months we have had less than seven inches of rain (the smallest for 20 years), it must be conceded that the crop has done remarkably well."

From Lehi (Utah) Banner, November 12, 1896:

"Owing to the recent storm, the farmers have not been digging their beets quite so fast as formerly. But a glance at the company's meteorological chart reveals the fact that we have been visited with a similar storm about this time of the season for the past three years. Also, providing the predictions of the chart prove true, we may expect a season of dry weather now, during which the beets will greatly improve."

We have given these extracts somewhat at length in order to show that in the districts where beets are grown successfully for factory purposes, the meteorological conditions are far from ideal; and that, at times, serious difficulties are encountered in harvesting and hauling to the factory. Not only so, but, at times, even the manufacture is unprofitable, due to the deteriorated character of the beets brought about by adverse climatic conditions. We think we have not given undue importance to this point. *We must insist that no effective argument can be made against the establishment of the beet sugar industry in this state, based on the character of our fall weather. We assert this not only because our rainfall and temperature are no more unfavorable than elsewhere, but also because the beets raised here are, for some reason, less sensitive to abnormal conditions.*

We have been asked many times if it would not be possible to have in this state one central refinery to which the crude product or raw sugar from small surrounding factories might be shipped. Our negative answer to this question has been met by the assertion that such is the arrangement in beet-growing Europe, and that what is done there can be done here. We wish to take this opportunity to state once again that the central refinery plan is not only not feasible, but wholly impracticable, for the State of Washington. Beet sugar factories erected here must refine their own product. It is true that 90 per cent. or more of the factories in Europe make only raw sugar. But in Europe there are practically no distances; the beet sugar industry is concentrated in a pretty small area, and

the refineries are located in the midst of the factories. Another important reason why the factories in Germany produce only the raw sugar, is because but little granulated sugar is used by the public. They use chiefly the "casted" cubes (not the American pressed tubes). To make these cubes requires a special kind of machinery, and the work is done by the refineries. The granulated sugar used in this country is the natural form of sugar when it crystallizes from solution. These sugar granules are the first product in European as well as in American factories; but here we purify these crystals and render them fit for consumption, while there they are left mingled with a large amount of molasses. The granulated product of an American factory polarizes 99.6 per cent. sugar, while the raw sugar taken to the refineries in Europe only polarizes about 88 per cent. The difference in the cost of a plant for turning out raw or granulated sugar is very small—hardly to be considered. It is the *output* which makes the difference in favor of the raw product. Suppose, for example, 10 per cent. of granulated sugar polarizing 99.6 per cent. is produced from beets of a given quality; then the same beets would yield about 12 per cent. of raw sugar polarizing 88 per cent. Even if both outputs be reduced to pure sugar, the *latter* is the most profitable. This is easily understood when we take into consideration the fact that the granulated sugar is washed with water in the centrifugal machines, during which washing some of the sugar is necessarily dissolved—running off as molasses. To be sure, this molasses is used over again, and some of the sugar recovered, but still the loss is a serious one. Although the manufacture of raw sugar may be more profitable, the time has not yet come in the United States for central refineries. The factories are too far apart, and freight charges too high for profit either to the manufacturer or refiner. At least thirty or forty factories are needed to supply one refinery, and until these factories are in existence, the plan cannot be successful. Two refineries have been established in the central portion of the United States, but both failed because of too great distance from the source of sugar supply, and lack of cheap transportation. The Chino (Cal.) factory shipped raw sugar one year to a refinery, but inasmuch as it has not been repeated, we conclude that the experiment was not a profitable one. *Washington needs beet sugar factories complete in themselves.*

In concluding this bulletin we wish to give grateful acknowledg-

ment to the following named persons, for valuable assistance rendered during the progress of the experimental work: E. B. Moulux, I. B. Harris, F. A. English, John R. Reavis, E. H. Morrison, Mr. and Mrs. Otto Wollweber, W. T. Clark, B. P. Shifflette, T. J. Patterson, J. Swinehart, J. W. Sefton, Henry Beckett, Supt. F. A. Huntley, J. C. Bush, C. M. Dietrich, A. A. Quarnberg, Leroy Brown and F. E. Deeringhoff. We also extend thanks to the press of the state for their coöperation and encouragement. We are convinced that much practical benefit to the material prosperity of the state will be the final outcome of this experimental work with the culture of the sugar beet.

SUMMARY.

The experiments of 1895 with acre tracts show that beets grown on a commercial scale in this state, possess as high and satisfactory character as those grown on small experimental plats.

From the estimates made by those growing the experimental acres, and others who have had experience in sugar beet culture, the cost of production when carried on commercially will not exceed and in all probability will fall below \$30 per acre.

From the yield furnished by beets, both in small areas and on acre tracts, it is safe to assert that under proper conditions of cultivation, in an average season, sugar beets will give an average yield of 18 to 20 tons per acre.

The experiments already conducted seem to indicate that Washington has a great future in the production of beet seed. Of course, it is not proven by the experiments of one year that the high character of our home-grown seed will be maintained throughout a period of years. As is well known, the tendency of all seeds is to deteriorate rather than to improve or even maintain their character. It has been only by careful work and selective processes in the matter of raising seed that the sugar beet has reached its present high state of development. It is not to be expected that good beet seed can be raised here by every one who attempts it. On the contrary, failure would follow the majority of such attempts. However, a thorough knowledge of the habits of the sugar beet, coupled with familiarity with the best methods of beet seed production, will undoubtedly lead to success in that industry.

Our climatic conditions, both as regards rainfall and temperature,

are as favorable to the successful cultivation of the sugar beet as those that exist in beet-sugar producing districts.

Beets raised in this state have a less tendency to take on a second growth or to be unfavorably affected by unusual conditions of the weather.

The central refinery plan is entirely premature for the conditions existing here and elsewhere in the United States.

APPENDIX.

Reference was made in the first pages of the foregoing records of experimental work to Bulletin 15. For the convenience of those who may not have this bulletin, we give herewith a condensed yet detailed summary of the results there recorded. This was issued as Press Bulletin No. 4 in December, 1894.

PRESS BULLETIN No. 4.

WASHINGTON AGRICULTURAL COLLEGE, EXPERIMENT STATION,
PULLMAN, WASH., Dec. —, 1894.

To the Editor:

Last spring the chemical department of the experiment station began a series of tests on the adaptability of Washington soil and climate to the production of sugar beets suitable for use in the manufacture of sugar. We advertised to furnish seed free of charge to all who would apply for the same and agree to follow certain specified directions for cultivation. The number of applications received was much greater than anticipated, and seed was furnished to 1,050 different parties. When the beets began to mature in the early fall, each man who received seed was requested to send samples for analysis, the station paying transportation charges. In response to this request beets were received from 372 farmers, coming from 101 different towns.

The very widespread interest manifested in this experimental work demands that the results obtained from the analyses should be equally wide spread, and the press of the state must be depended upon to make these results known to the largest number possible.

There are included in the above, 1,666 analyses of seven different varieties of beets, which give a general state average of 14.2 per cent. sugar and a purity of 82.6. One variety, the "Vilmorin Improved," has shown itself to be wholly unadapted to our soil and climatic conditions. Of this variety 122 analyses were made which averaged only 11.1 per cent. sugar, and purity 77.0. Eliminating this variety from the general average, we have 1,544 analyses which give for the entire state the following average: *Weight, 22 oz.; sugar, 15.2 per cent.; purity, 83.8.* This is a remarkable showing, particularly as regards purity.

Beets were received and analyzed from 45 towns west and 56 east of the Cascade mountains. The following comparison will be of interest when we consider the wide variations of conditions between these two portions of the state:

<i>Locality.</i>	<i>No. of towns.</i>	<i>No. of analyses.</i>	<i>Average wt. of beet.</i>	<i>Av. per cent. of sugar.</i>	<i>Average purity.</i>
Eastern Washington.....	56	1,270	23 oz.	14.9	82.4
Western Washington	45	396	26 oz.	13.3	82.8

These averages include all analyses. Eliminating from them the variety "Vilmorin Improved" the following results are obtained:

<i>Locality.</i>	<i>No. of towns.</i>	<i>No. of analyses.</i>	<i>Average wt. of beet.</i>	<i>Av. per cent. of sugar.</i>	<i>Average purity.</i>
Eastern Washington.....	56	1,188	21 oz.	15.5	83.8
Western Washington.....	45	360	24 oz.	14.9	83.8

The above results seem to demonstrate beyond a doubt that the state of Washington is preëminently adapted to the culture of beets for sugar making purposes. We are very much gratified with the hearty coöperation that has been extended to us in the work, and the general interest that has been manifested. Reports will be sent as soon as possible to all who furnished samples for analysis.

Further experiments will be carried on next year with special reference to the yield per acre and cost of production. Seed will again be distributed *free of cost* to those who apply. It is hoped that many will coöperate with us in this next year's work. Applications for seed should be made not later than March 1.

In the meantime let every one interested in the material development of our state, keep the sugar beet question thoroughly agitated; let sectional feelings give way to the general welfare, and it will not be many years before all the sugar consumed in our state will be manufactured within her borders.

The following tables are self explanatory :

WESTERN WASHINGTON.

Town.	County.	No. of analyses.....	Av. weight of beet in ozs.....	Av. per cent. of sugar.....	Av. purity.....	Best single analysis.		Poorest single analysis.	
						Sugar....	Purity..	Sugar....	Purity..
Agate.....	Lewis.....	6	15	13.7	84.5	14.5	85.3	13.0	84.5
Acme.....	Whatcom.....	4	31	9.6	80.3	10.6	81.8	8.2	73.2
Arlington.....	Snohomish.....	2	40	12.8	80.0	12.9	81.6	12.7	78.4
Blaine.....	Whatcom.....	4	42	14.4	89.2	15.9	92.4	11.8	81.4
Baker.....	Skagit.....	6	58	13.5	84.8	14.5	88.9	12.0	76.9
Beach.....	Whatcom.....	2	23	11.2	78.0	11.5	79.9	10.8	76.1
Coupeville.....	Island.....	6	44	14.2	87.7	14.8	88.6	13.4	87.0
Cedarville.....	Chehalis.....	6	42	12.1	83.2	14.0	85.4	9.8	80.7
Cowlitz.....	Lewis.....	8	17	12.6	81.5	15.5	85.6	8.5	74.5
Centralia.....	Lewis.....	3	5	15.3	83.2	15.8	86.3	15.0	82.0
Chehalis.....	Lewis.....	8	22	12.6	78.6	13.3	79.2	11.7	80.7
Dungeness.....	Clallam.....	21	80	10.2	81.0	15.3	86.4	6.3	70.0
Elma.....	Chehalis.....	12	35	12.6	78.9	14.2	84.0	11.5	79.3
Enterprise.....	Whatcom.....	20	16	14.9	85.8	16.7	90.7	12.3	74.1
Fidalgo.....	Skagit.....	7	3	16.4	88.6	18.3	88.4	13.8	85.2
Fern Hill.....	Pierce.....	7	12	14.9	84.5	16.9	87.5	13.0	74.3
Florence.....	Snohomish.....	4	54	12.2	84.6	14.4	90.6	9.2	74.2
Home Valley.....	Skamania.....	1	3	12.4	82.7	.....	.....	.....	.....
Hartford.....	Snohomish.....	16	18	14.7	87.5	17.0	92.4	11.0	80.9
Iiwaco.....	Pacific.....	22	18	14.4	84.4	17.0	93.4	10.4	74.3
Kent.....	King.....	18	20	13.3	79.0	16.5	84.6	10.0	70.9
Kelso.....	Cowlitz.....	2	36	14.6	83.5	15.5	86.5	13.7	80.6
Kalama.....	Cowlitz.....	6	26	13.1	83.4	13.8	84.7	11.1	78.2
La Conner.....	Skagit.....	14	24	14.5	86.0	17.4	92.5	12.6	80.8
Markham.....	Chehalis.....	4	27	15.6	91.4	16.1	96.4	14.9	87.6
Montesano.....	Chehalis.....	12	35	11.4	77.7	16.8	92.3	5.4	60.0
Menlo.....	Pacific.....	12	17	16.1	88.8	17.8	95.2	13.7	82.5
Marysville.....	Snohomish.....	10	17	13.0	79.6	15.1	92.6	11.1	72.6
Norman.....	Snohomish.....	4	45	12.5	83.3	15.1	87.8	10.5	80.7
Nooksack.....	Whatcom.....	4	34	15.2	86.3	16.4	90.1	13.0	78.3
Napavine.....	Lewis.....	11	26	13.5	81.4	15.8	86.3	11.5	76.7
Newcastle.....	King.....	6	21	11.5	72.0	13.4	78.4	10.0	67.1
Orting.....	Pierce.....	16	26	14.4	85.4	16.0	88.9	9.4	75.8
Quilcene.....	Jefferson.....	12	33	13.7	88.8	16.7	91.7	10.3	83.8
Roche Harbor.....	San Juan.....	2	38	9.9	64.9	10.9	69.0	9.0	60.9
Sedro.....	Skagit.....	8	21	13.3	80.1	14.0	79.1	12.3	78.9
Sultan.....	Snohomish.....	10	34	14.8	91.3	16.5	94.3	12.2	87.1
Skamokawa.....	Wahkiakum.....	4	31	14.1	81.4	15.2	86.9	12.4	74.7
Toledo.....	Lewis.....	41	22	14.0	84.7	17.1	90.0	7.7	74.0
Willapa.....	Pacific.....	2	13	15.7	87.7	17.6	90.2	13.9	85.3
Whatcom.....	Whatcom.....	12	15	11.8	77.9	13.6	79.5	9.0	69.2
Woolley.....	Skagit.....	4	28	13.3	80.0	14.2	85.5	12.5	78.7
Wickersham.....	Whatcom.....	7	12	13.0	81.0	13.7	83.0	12.0	87.0
Wana.....	Snohomish.....	6	41	11.4	77.5	14.7	87.5	7.7	64.1
Wabash.....	King.....	4	12	11.8	82.2	11.9	83.8	11.7	88.6

EASTERN WASHINGTON.

Town.	County.	No. of analy- ses.....	Av. weight of beet in ozs.....	Av. per cent. of sugar.....	Av. purity.....	Best single analysis.		Poorest single analysis.	
						Sugar.....	Purity ..	Sugar.....	Purity ..
Asotin.....	Asotin.....	23	13	16.7	85.3	21.9	92.7	12.0	77.4
Aurora.....	Whitman.....	6	17	14.3	84.9	16.1	86.1	12.5	87.4
Anatone.....	Asotin.....	8	19	15.3	83.5	18.1	86.2	13.6	80.0
Belmont.....	Whitman.....	5	47	15.2	80.2	16.5	84.2	14.6	77.6
Covello.....	Columbia.....	4	22	15.7	89.9	16.5	91.1	15.0	88.2
Chewelah.....	Stevens.....	2	27	8.3	58.7	10.0	65.3	6.5	52.0
Cheney.....	Spokane.....	8	35	15.4	80.5	17.2	87.0	13.9	74.3
Crescent.....	Lincoln.....	41	15	15.5	83.1	19.4	82.6	10.7	84.9
Colfax.....	Whitman.....	129	22	15.2	84.1	19.8	94.3	11.6	83.1
Colville.....	Stevens.....	11	22	15.8	86.1	19.8	87.2	13.4	81.7
Colton.....	Whitman.....	24	33	14.2	80.5	17.2	86.9	4.7	50.5
Dayton.....	Columbia.....	54	19	16.0	84.1	21.1	93.3	7.0	62.5
Davenport.....	Lincoln.....	10	7	16.9	78.4	19.3	88.9	10.3	51.5
Diamond.....	Whitman.....	9	18	15.8	85.7	20.9	92.0	12.5	69.1
Dixie.....	Walla Walla.....	8	22	14.4	86.1	15.1	91.5	13.5	83.3
Delight.....	Adams.....	2	3	10.6	81.5	11.6	78.9	9.5	84.1
Ellensburg.....	Kittitas.....	98	10	15.9	85.2	20.0	94.7	9.5	76.6
Fletcher.....	Adams.....	6	10	14.0	86.0	15.3	86.4	10.5	84.7
Fairfield.....	Spokane.....	74	13	15.4	85.3	17.6	92.1	10.3	72.0
Farlington.....	Whitman.....	20	53	12.3	78.1	15.0	82.9	5.8	57.4
Fallons.....	Whitman.....	6	14	15.8	89.1	17.4	85.6	13.5	87.1
Garfield.....	Whitman.....	46	17	15.2	85.4	19.8	96.6	10.1	77.7
Guy.....	Whitman.....	25	24	15.3	85.5	17.8	90.3	10.9	72.1
Gould City.....	Garfield.....	2	48	14.3	80.3	14.6	81.1	14.0	79.5
Harvey.....	Stevens.....	8	24	15.7	82.4	17.7	86.3	12.0	71.4
Kettle Falls.....	Stevens.....	8	12	15.6	85.0	17.1	89.1	13.8	76.7
Larene.....	Lincoln.....	4	10	17.2	92.7	28.5	95.7	15.0	90.9
Latah.....	Spokane.....	20	26	14.5	82.4	17.0	82.5	11.0	77.5
Marshall.....	Spokane.....	2	45	13.2	81.6	14.2	85.0	12.2	78.2
Medical Lake.....	Spokane.....	6	15	14.4	74.3	18.5	78.0	11.2	66.1
Mayview.....	Garfield.....	13	34	14.2	78.5	16.6	84.7	11.9	69.6
Oakesdale.....	Whitman.....	21	38	13.5	80.5	16.6	86.5	9.3	77.5
Pomeroy.....	Garfield.....	32	37	14.8	80.1	17.6	82.2	11.0	66.6
Palouse.....	Whitman.....	23	15	15.6	83.8	18.6	88.6	12.9	81.1
Prescott.....	Walla Walla.....	6	30	15.7	84.3	17.5	89.7	13.7	81.1
Pine City.....	Whitman.....	6	23	16.8	85.5	18.8	87.4	14.8	81.3
Pullman.....	Whitman.....	106	20	15.8	84.4	19.4	89.8	12.3	77.4
Pataha.....	Garfield.....	9	36	13.0	79.0	16.6	86.5	10.8	71.1
Plaza.....	Spokane.....	8	27	16.1	85.5	19.3	91.4	13.2	75.9
Reardon.....	Lincoln.....	18	19	16.4	84.3	17.9	86.9	14.3	71.1
Rockford.....	Spokane.....	8	15	13.7	82.1	15.1	86.8	12.9	83.8
Rosalia.....	Whitman.....	15	16	16.7	89.4	19.6	90.3	14.3	82.2
Riparia.....	Columbia.....	4	14	15.9	85.9	16.3	90.5	13.9	81.3
St. John.....	Whitman.....	5	7	15.4	85.9	16.8	89.4	14.1	83.4
Steptoe.....	Whitman.....	12	43	14.5	82.1	16.8	87.4	12.0	70.6
Sprague.....	Lincoln.....	3	4	14.6	67.6	15.5	75.6	13.0	58.0
Starbuck.....	Columbia.....	6	18	13.8	75.9	17.0	84.6	11.4	70.3
Spokane.....	Spokane.....	32	19	15.5	82.6	19.8	94.1	12.6	76.8
Sunset.....	Whitman.....	4	42	14.2	82.9	16.1	88.4	11.9	78.8
Tekoa.....	Whitman.....	19	20	14.2	82.3	17.4	91.1	11.1	79.9
Uniontown.....	Whitman.....	120	28	15.2	82.7	18.2	89.2	11.2	75.7
Unknown.....		36	18	15.7	85.1	21.5	90.7	8.5	72.7
Waverly.....	Spokane.....	65	18	15.1	84.4	17.8	87.6	9.5	80.5
Welch.....	Spokane.....	12	12	15.1	79.8	18.3	88.4	12.4	71.6
Walla Walla.....	Walla Walla.....	14	66	12.2	74.4	17.5	81.8	7.0	49.6
Yakima City.....	Yakima.....	4	23	13.8	80.1	14.4	82.3	13.0	78.3

